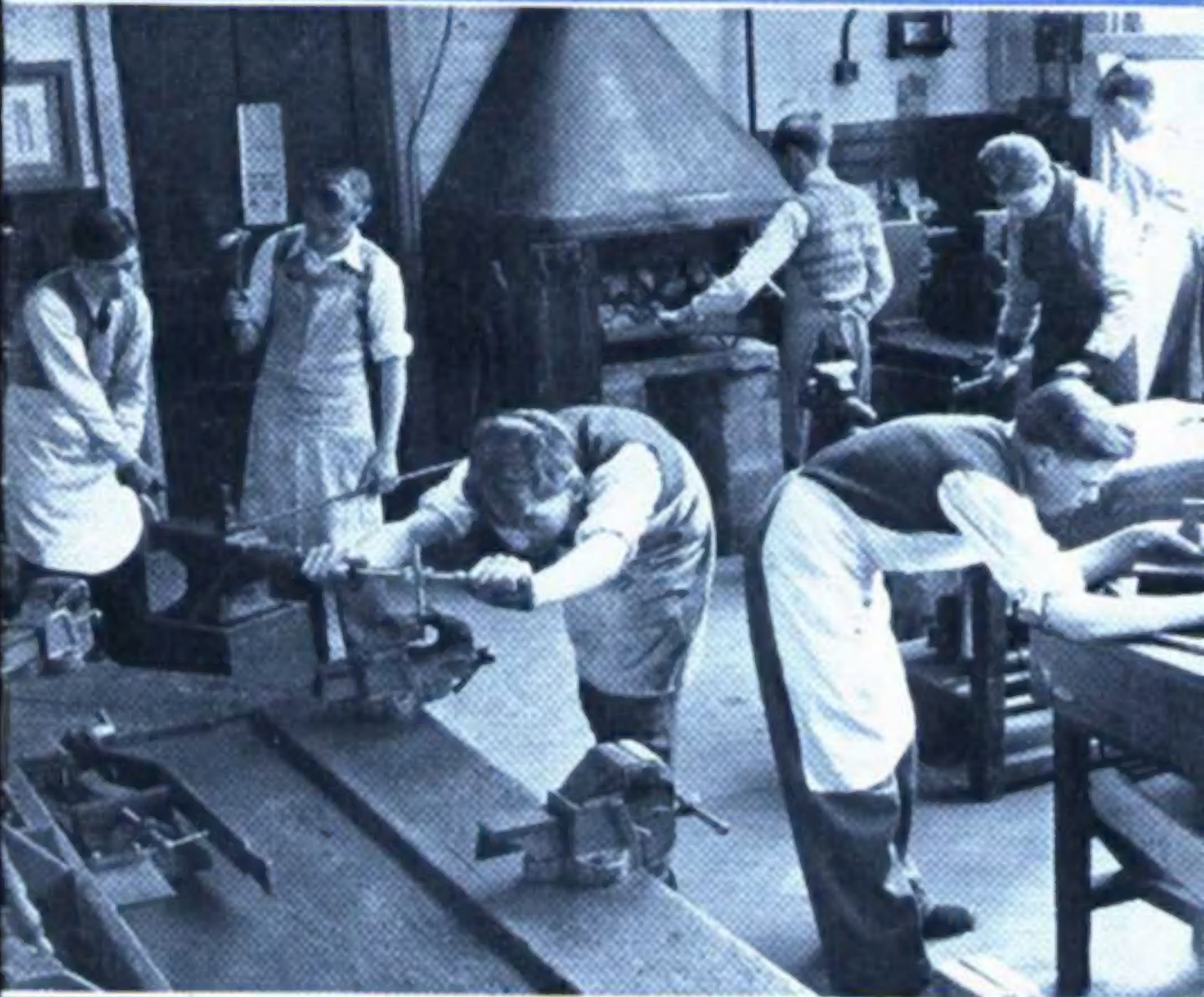
THE MODEL ENGINEER



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THE MODEL ENGINEER

EVERY THURSDAY

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Our Cover Picture

This photograph shows a corner of the metalwork shop at Bifrons Secondary School, Barking, and was taken during the period of development described in the article on page 608.

Two gas blowpipes are used for forging processes, but it is hoped to extend the workshop and install a forge. Behind the boy at the brazing hearth is the polishing and grinding head and the compressor with air lines to the two brazing hearths. On the bench in the foreground is the partly-completed hacksaw machine which, later on, was found to stand up to its specified 3 in. capacity with a perfect right-angle cut.

The boys' first introduction to the shop is at the age of eleven. During the ensuing four years they master the elements of fitting, forging, copper-smithing and turning, and by the time they leave, many to proceed into industry, machines have lost their terror and thousandths of an inch are almost commonplace.

SMOKE RINGS

Enthusiast at Work

WE ARE glad to learn that, in spite of a cold and boisterous wind, the Malden Society's first "Track Sunday" of the year was a great success. There were often as many as four, and even five locomotives on the track at the same time, and visitors came from Farnborough, Horsham, Acton, Harrow, etc.

Mr. Tucker, of Farnborough, ran a very fine 3½-in. gauge S.R. "Schools" class engine, as yet unfinished and fitted with a temporary tender; but a very noticeable feature of this engine was the beautiful finish of the spokes on its wheels. Mr. Tucker explained that this finish had been obtained simply by careful filing. In the workshop, of course? Oh, no; in the train travelling from Farnborough to business every day!

We have often noticed that very few people take the trouble to put any sort of finish on wheels; it isn't worth it, you know; and in any case it does not affect the working of the engine. Ye gods! let Mr. Tucker's enthusiasm be an example to us all!

The Price of Things!

IN THE present age of high prices, it is perhaps hardly surprising that many of our readers find their hobby more expensive than they had bargained for. We know full well that most of our advertisers are doing their utmost to keep prices of tools, equipment, and materials as low as possible, and have many difficulties of their own in this respect to contend with; but we occasionally encounter cases where the prices which have been charged for certain articles seem, on the face of it, to be exorbitant. While we do our best to redress any grievances of this nature which are brought to our notice, it is extremely difficult for us to take action after a deal has been actually completed, and we therefore advise readers to take due precautions before buying, rather than making complaints afterwards. The old precept, *caveat emptor* (let the buyer beware!) is not only sound common sense but also has some legal significance. Most advertisers issue lists giving current prices of their goods, although it is not easy to keep pace with the rapid fluctuations of prices which are at present the rule rather than the exception. We have noticed, however, that there are wide discrepancies in prices of raw materials, in particular, which do not seem to be accounted for by proportionate differences in quality; in one case recently investigated, it was found that goods sent by post were charged at a much higher rate than when sold over the counter. In view of the fact that an additional charge was made for postage and packing, we are at a loss to understand the justification for this policy. As the great majority of our readers are of what is officially known as "the lower income groups" the question of expense is of paramount importance to them, and may be the decisive factor as to whether they continue to make models, or seek some less expensive spare-time pursuit. We would assure them that we are doing all that is within our power to guard their interests, and to ensure that they get value for money in all goods advertised in THE MODEL ENGINEER.

A Lincoln Exhibition

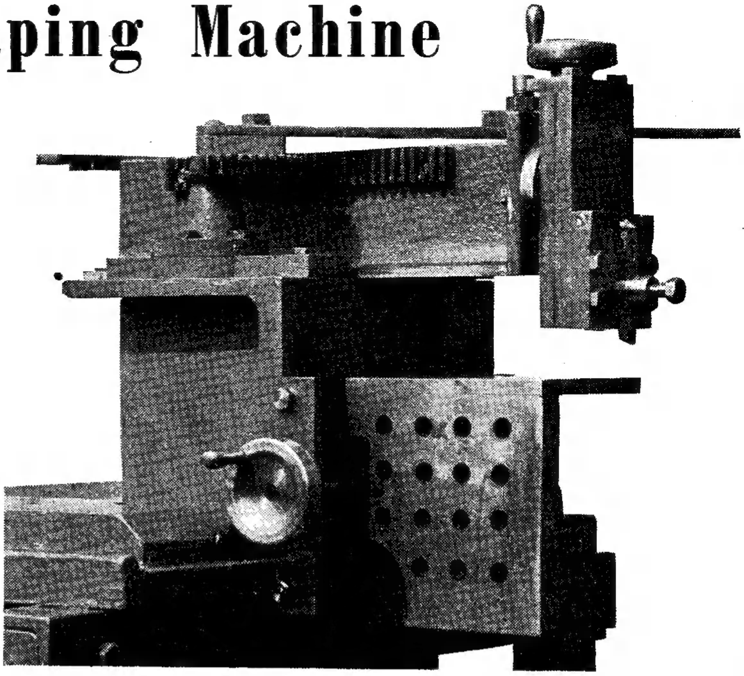
WE HAVE received from Mr. G. T. Sindall, of the Lincoln Model Engineering Society, a note announcing that there is to be a Coronation Year exhibition in that city. It will be held at the Lincoln Technical College from August 29th until September 5th next, inclusive, and the society invites any local lone hands and neighbouring societies to co-operate by loaning models of all kinds, but especially boats. Efforts are being made to stimulate interest in the boat section.

Mr. Sindall has been appointed Exhibition Secretary of the Lincoln M.E.S., his address is 53, Geneva Avenue, Lincoln.

A Hand Shaping Machine

An article describing a useful item of equipment made by schoolboys

By F. C. Patching

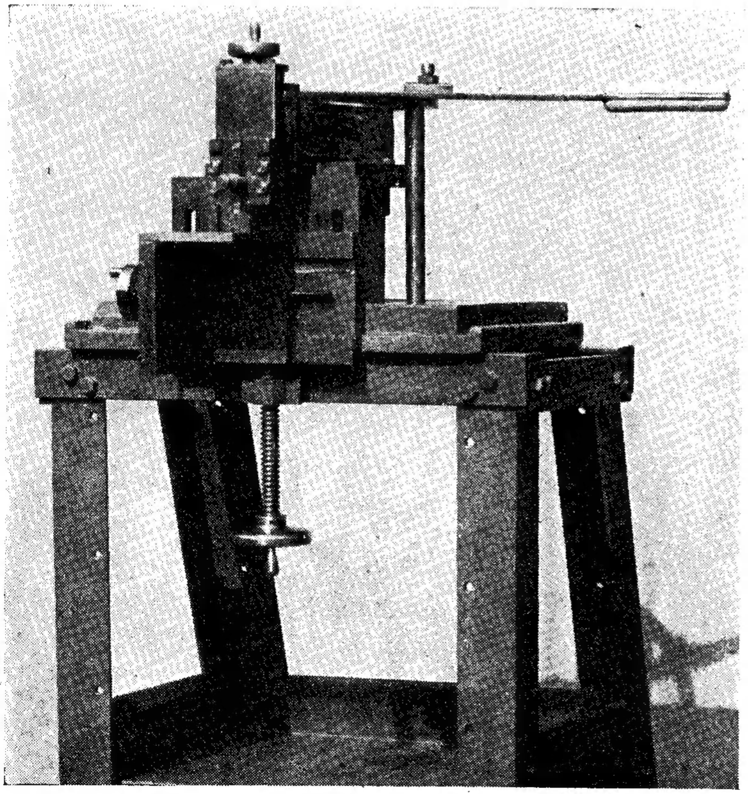


The driving mechanism, showing rack and quadrant

THE shaping machine shown in the accompanying photographs is a modification of the shaper described by Mr. F. T. Leightwood in the issue of THE MODEL ENGINEER dated June 9th, 1949.

This machine was built by 14-year-old boys of Bifrons Secondary School, Barking. Construction began during June, 1951, with the machining of the ram and base, and later, work recommenced in earnest after the summer holidays. Two boys were responsible for the actual machine whilst a further group made the stand.

In addition to the more usual lathes and drilling machine, there is a small horizontal milling machine which, although it cannot take work longer than 7 in. at one setting, gave valuable service in producing the sliding parts.



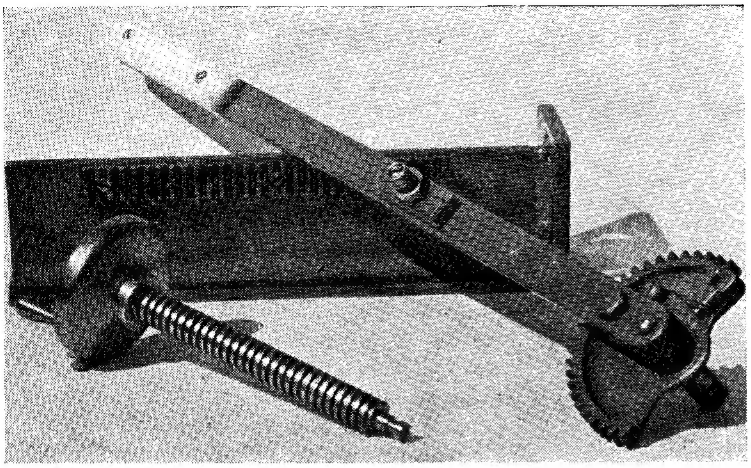
The finished shaper and stand

A number of modifications were made in the original design, some to fit the machine for use in the school workshop, whilst others were dictated by available material.

A boiler plate, with an 8 in. length of 6 in. × 6 in. × $\frac{3}{8}$ in. angle bolted to it, formed the base. To compensate for the rather thin angle, two pieces of 5 in. × $\frac{3}{4}$ in. B.D.S. were fixed underneath between the angle and base plates.

An 8 in. length of 5 in. × $\frac{3}{4}$ in. B.D.S. was machined to provide the vertical guide at the back, and the horizontal slides were milled to an angle of 60 deg. The vertical adjusting-screw was added to simplify the adjustment of the baseplate. It can then be locked in position by means of two nuts behind.

The ram, 12 in. of 3 in. × 3 in. T-sectioned bar, was milled to 60 deg. and also machined on the top edges so that the guide strips overlapped the top, ensuring a steadier movement of the ram. The ram is operated from a quadrant, a motor-cycle kick-start from the scrap box, with a rack bolted on the side of the ram. The rack was cut



Close-up view of ram, operating handle and adjusting screw

on the milling machine, drilled and fitted and then case-hardened.

The post that holds the quadrant is bolted to the top of the base angle. The handle can be removed and the quadrant engaged with the rack in the most convenient position for any particular operation.

The operating lever runs on a circular track forged from a length of $\frac{3}{4}$ in. × $\frac{3}{8}$ in. mild-steel. A spring-loaded ball-bearing is fitted to the handle to reduce friction on this track.

The vertical slide and clapper box are similar in construction to the original design, although most dimensions are slightly larger. A gib strip has been added to ensure a clean cutting action.

The stand was made from angle iron and bolted together. A plate bearing the names of the two chief "engineers" was cast and bolted on the side of the ram.

The photographs were taken by E. Johnson who co-operates with the activities of the workshop and produces the drawings and prints in the school drawing office.

The method of construction of the stand can be clearly seen in one of the photographs—also the track for the operating lever. The heading photograph shows the quadrant mounting bolted to the baseplate and the driving quadrant and rack.

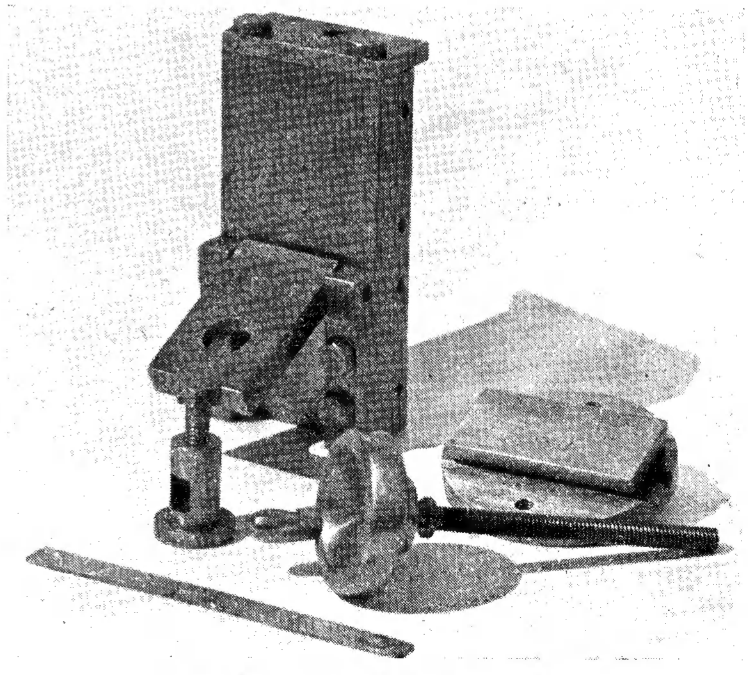
The slide and its components are somewhat more robust than the original, to stand up to the needs of the school workshop. The welding on the ram and table were beyond the scope of the shop, but an "old" boy of some three months' experience as a welder came to our aid and executed this operation.

This machine is the latest addition to the workshop which has been growing steadily since 1934. The original equipment included a Bantam lathe and a hand bench drilling machine. The bench drill survived two years of hard work and then we were allowed to install a pillar drill driven from a line shaft by a $\frac{3}{4}$-h.p. motor. The line shaft enabled a polishing and grinding head to be added.

During the war the shop became an A.R.P. repair depot, but with a return to normal conditions and a change in the school boiler system, we acquired a $1\frac{1}{2}$-h.p. motor. This was used to drive the line shaft and the Burke No. 4 horizontal miller, a war surplus machine, joined the drill and the grinding head.

The $\frac{3}{4}$-h.p. motor was used to drive an air compressor—a garage tyre compressor—thus giving more power to the brazing hearths. The Education Authority purchased a $4\frac{1}{2}$-in. Boxford lathe and the boys built a cabinet stand from *ex*-air raid shelter angle-iron. A start was now made on the hacksaw machine described by Mr. R. F. M. Woodforde in THE MODEL ENGINEER of February 23rd, 1950, who provided us with a set of castings. When completed, the hacksaw machine replaced the grinding head on the main line shaft and a shorter line shaft was now installed to run the compressor and grinding head.

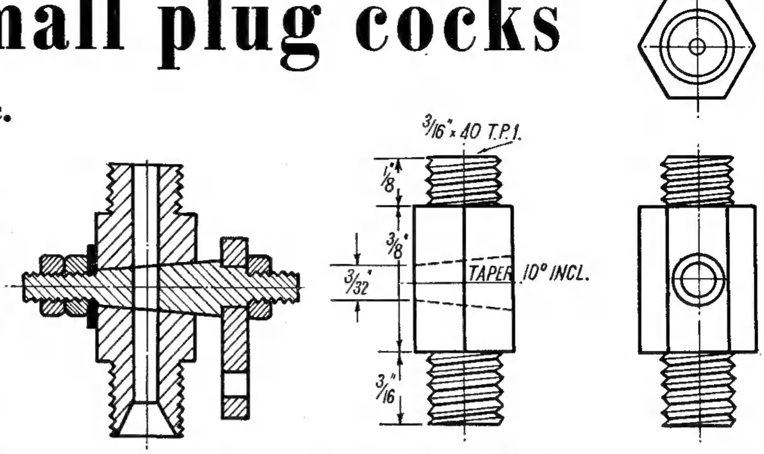
All these installations, other than electrical work, were carried out by the senior boys, aided after the war by an evening class of old boys. In addition, the boys produce many of the small tools used in the workshop, including scriber and dial gauge stands, die stocks, tap wrenches, planishing stakes and copper work hammers. It is now a privilege to be allowed to make something for their workshop.



Details of vertical slide and clapper box

Making small plug cocks

By H. E. White, B.Sc.



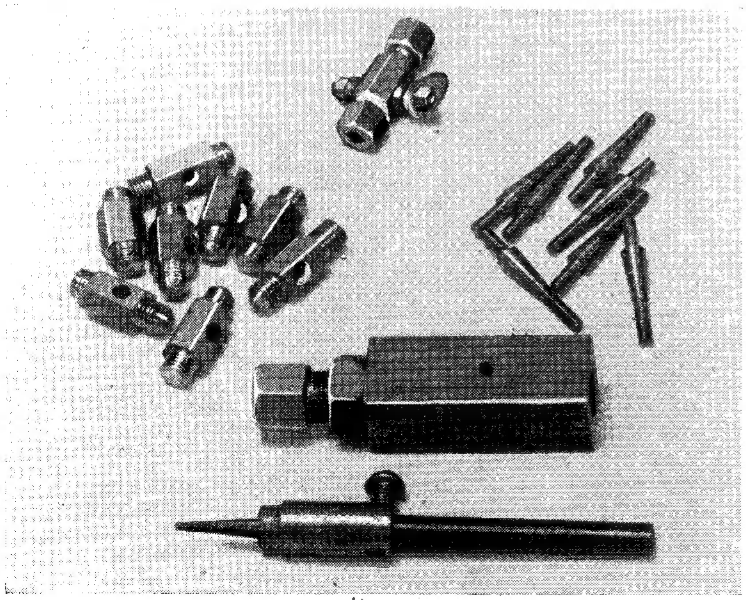
Section of cock and details of body

IN the past, many model engineers have habitually purchased certain components, such as steam pressure-gauges, as being too difficult, or " fiddling " for production in the home workshop, whilst certain other small parts which are produced in large numbers by production methods, such as nuts, bolts, washers and rivets, have been purchased rather than made at home, in order to save time. Drain cocks of the plug-cock type, for boiler fittings and cylinder drains have been regarded as belonging to the latter group, being " more trouble than they are worth " although, strangely enough, where the plug-cock could be replaced advantageously by a screw-down valve, most model makers had no objection to making these ! Prices have now risen to such a level as to render the production of such small components not only well worth while, but, in the case of many model engineers, a necessity, and the following is a description of the production of a number of small plug-cocks to be used as cylinder drain cocks.

Two or three of my engines, produced since the war, have had their drains plugged with screwed stubs of brass rod until such time as suitable cocks could be purchased. As the numbers required increased so did the possible cost of procuring them, and the decision was at last made to make them up at home, the number required being about thirty.

The bodies of the cocks are made from hexagon brass rod, as, amongst other advantages, the flat surfaces make it unnecessary to spot-face the ends of the tapered holes. This means, of course, that the traditional globular shape has not been adopted. There is, however, no reason why anyone producing cocks from this design should not carry out the additional operation of turning the body to the usual profile with a form-tool. Similarly, plain washers and lock-nuts have been provided to retain the tapered plug, as this arrangement does away with the need for (*a*) a squared small-end to the plug, and (*b*) a very small square-holed washer in the traditional fashion. The small nuts and washers used in this design (8-B.A. brass) are, of course, easily obtainable commercially. In fact, the only job of any difficulty in the whole design is perhaps the production of the square hole in the lever, a complication which it was considered necessary to retain in view of the possibility of the plug becoming partially stuck. However, the making of a suitable drift to produce this hole is justified when a fair number of parts is required, as in this instance. It was also found to be an advantage to make up certain simple jigs and fixtures to save time and ensure accuracy, whilst a filing-rest for the lathe is also very useful if the squared ends of the plugs are to be formed exactly to size without wasting time in fitting them to the square holes.

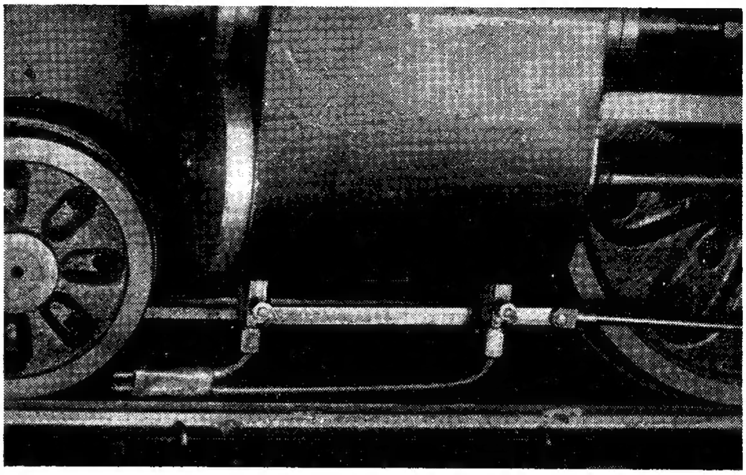
The first job is to part off the required number of $\frac{11}{16}$-in. lengths of $\frac{1}{4}$-in. hex. brass rod. This was done by mounting a length of steel rod in the tailstock chuck to act as a " stop." Slacken the chuck jaws, advance the brass hex. until it touches the stop, and adjust the top-slide until the parting tool is in the correct position to part off the first piece to length. When this



Photograph showing cock bodies and tapered plugs, with a finished drain-cock. The ools are a tapered reamer with depth stop, and the cross-drilling jig

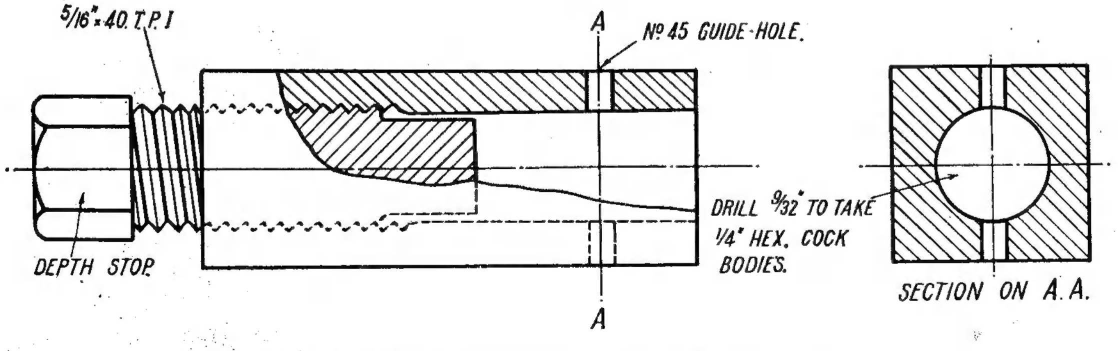
has been done, a number of similar pieces can be parted off without moving the saddle, simply slacken the chuck, advance the rod to the stop, and part off. The next operation is to chuck each piece, shoulder one end down to $\frac{3}{16}$ in. diameter for a depth of $\frac{1}{8}$ in. and screw $\frac{3}{16}$ in. × 40 t.p.i. To do this quickly, an "internal" stop was rigged up. This was the tapered shank of an old drill, which was drilled and tapped to take a length of $\frac{3}{16}$-in. steel rod. The tapered shank fitted in the mandrel taper, and the steel rod projected between the chuck jaws. The steel rod was cut to such a length that it prevented the brass blanks entering the jaws for more than about half their length, and thus each one projected exactly the same distance from the chuck. The shouldering is done with a knife tool: adjust the slide until the tool will turn the shoulder to $\frac{3}{16}$ in. diameter at one cut. When the first shoulder has been turned to a depth of $\frac{1}{8}$ in. fix a stop on the lathe bed (an ordinary tool-maker's cramp will do) to limit the movement of the saddle. Put a $\frac{3}{16}$ in. × 40 die in the tailstock die-holder. Now all you have to do is to push the brass blank into the chuck jaws until it touches the stop, and tighten the jaws. Bring up the saddle with the rack-wheel or lead-screw handle until it touches the lathe-bed stop. Note the cross-slide index reading (or set the dial to zero), withdraw the tool a few turns, and cut the thread. Remove the blank, insert another and repeat the job on the rest of the blanks. The screwed shoulder at the other end of the blank is done in exactly the same way, except that the stop on the lathe-bed must be moved so that the shoulder is cut to a depth of $\frac{3}{16}$ in.

Now for the cross-drilling. This *can* be done without a jig, as the hole is drilled across the flats, and, therefore, the piece will rest firmly on the drill table. Each piece would need to be accurately centre-punched, of course, which would take time. To avoid this, a simple jig can be used. It is made from a piece of $\frac{3}{8}$-in. square steel. It was found that the $\frac{1}{4}$-in. hex. rod was a nice snug fit inside a 9/32-in. hole, and so the square steel can be mounted in the 4-jaw chuck, centred, and drilled through 9/32 in. Remove it, and carefully scribe a line along one side exactly in the middle, and make a centre-punch dot on this line at a distance of $\frac{1}{4}$ in. from one end. At this point drill a No. 45 hole as shown in the drawing. The other end of the 9/32 in. hole is tapped $\frac{5}{16}$ in. × 40 to take the stop-screw, which is turned up from a short length of $\frac{3}{8}$-in. hex. steel. To set the jig, scribe a line across one of the blanks exactly mid-way between the shoulders, insert it in the jig until the scribed line passes under the No. 45 hole, and screw up the stop-screw until the line is exactly under the centre of the hole. If the stop-screw is at all loose, fit a lock-nut to keep it from moving. Each blank can now be inserted in the jig, its position adjusted so that two of the flats are horizontal, and the cross-hole drilled through the guide-hole.

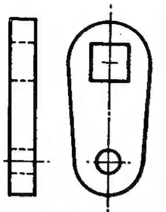


A pair of drain-cocks fitted to a $3\frac{1}{2}$-in. gauge locomotive. The operating levers are on the inside

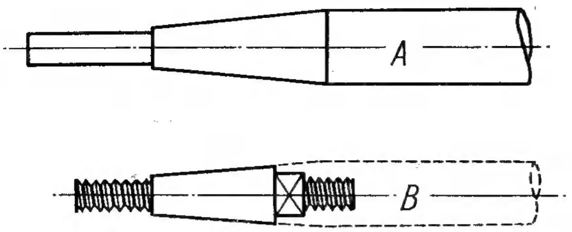
The cross-hole is tapered with a half-round or D-bit reamer. Put a piece of $\frac{3}{16}$ in. diameter silver-steel rod in the chuck and set it to run truly. Set the top-slide over to 5 deg., and turn a taper on the steel rod until the small end is no more than about $\frac{1}{16}$ in. diameter. A good tool finish must be aimed at, the best tool for the job being a knife-tool with the extreme point stoned slightly to form a microscopic round-nose. Unless your top-slide is accurately indexed, do not alter this angular setting, as you will need it to turn the plug blanks. Remove the silver-steel and carefully and accurately file away half the taper to form the cutting edges. Harden and temper to a light straw colour.



Cross-drilling jig for cock bodies, made from $\frac{3}{8}$-in. square steel



Lever—$\frac{1}{16}$ in. mild-steel plate



Turning the plugs. "A" shows the shank and taper before cutting off the blank, "B" is the finished plug

Now make up a little depth-collar from a piece of $\frac{5}{16}$ in. round steel; drill through $\frac{3}{16}$ in., and cross-drill and tap 4 B.A. for a set-screw. This fits over the shank of the reamer, and can be set so that it limits the depth to which the reamer enters the hole. The reaming is best done in the drilling machine; rest the blank on a drilled block, and feed in the reamer at slow speed until the larger end of the tapered hole is about $\frac{1}{8}$ in. diameter. Set the depth-collar when this has been done, and the rest of the holes can then be reamed out very quickly.

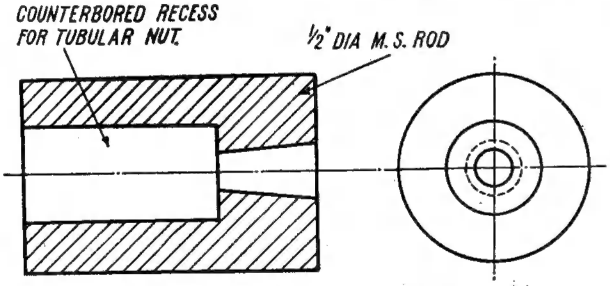
The plugs are made from $\frac{3}{16}$ in. diameter bronze or stainless-steel rod. The turning proceeds in two stages. Set the top-slide index to zero and, using the rack traverse, or the leadscrew handle, turn the parallel shank to 0.087 in. diameter for the 8-B.A. threaded shank. Note the cross-slide reading so that the tool may be reset quickly for the other shanks. Now, using the top-slide handle, the top-slide being still set over 5 deg., turn the taper, so that the job looks like *A* in the drawing. Screw the shank 8 B.A. either with a die-holder held in the hand or in the tailstock, and if you have a parting tool mounted in an inverted position at the back end of the cross-slide, part off the plug blank. If you have no back parting-tool holder, use a small 6 in. Eclipse saw for the job, as the length of the plain end of the plug is not critical. Repeat until you have enough blanks—a few extra will be useful in case any of them are spoiled in subsequent operations.

Now a small fixture must be made up to hold the plugs. This is a short length of $\frac{1}{2}$ in. diameter round steel, drilled 3/32 in. and reamed to form the taper. The depth collar will ensure that the taper is exactly the same as the hole in the cock-bodies. Reverse the piece in the chuck and counterbore with a $\frac{1}{4}$ in. drill as shown in the drawing. The "nut" which is used to secure the plug blanks firmly in the tapered hole is made from a length of $\frac{3}{16}$-in. diameter brass rod, knurled at one end—although this is hardly necessary—and drilled and tapped 8 B.A. at the other end. The fixture is used in the following way. Insert the plug blank, give it a slight tap to make it a snug fit, and screw the "nut" on the shank of the plug. Chuck the fixture in the self-centring chuck—or a collet—and turn down to 0.087 in. diameter to within $\frac{1}{8}$ in. of the face of the fixture. A small piece of $\frac{1}{8}$-in. steel strip can be used as a gauge, or a stop fixed on the lathe-bed. Screw the shank thus formed 8 B.A. Repeat for all the blanks without altering the setting of the tool.

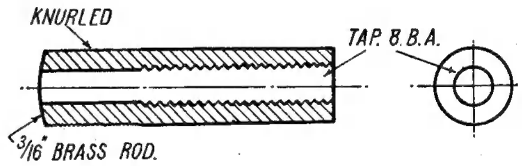
The next job is to make up the levers. They can be made up most conveniently from a length of $\frac{3}{16}$-in. $\times$ $\frac{1}{16}$-in. steel strip, leaving the actual cutting until all the drilling and squaring has been done. The holes are $\frac{1}{16}$ in. and 3/32 in., the 3/32-in. hole being cut square after drilling, using a tapered drift for the job. This is made from a short piece of 3/32 in. square silver-steel. File off one end to a taper, finishing about $\frac{1}{16}$ in. square. Along the tapered portion teeth are cut, like steps, using a fine Swiss file. The drift is then hardened and tempered to a dark straw colour—it musn't be too brittle—and it is pushed through the 3/32-in. holes with the vice jaws, putting a drilled pad behind the work so that the drift can pass through freely. The rest of the job is simply sawing and filing to outline.

Now for the square on the plug. This *can* be done by hand, using the square hole in the lever as a gauge, but this is likely to be a long job when there are a large number of plugs to be squared. The job can be done much more quickly and satisfactorily in the lathe by using a filing rest fitted to the cross-slide. Once the first square has been filed and fitted, and the filing rest correctly adjusted for height, the remainder can be finished off very rapidly. When these are all done, fit a lever to each plug and screw on the fixing nut tightly. Grind each plug gently into its tapered hole, using a little metal polish as an abrasive. Wash away all traces of the polishing medium with paraffin, and fit each plug into its own cock-body, put on the 8-B.A. washer and the two nuts, screwing them up so that the plug is tightly held, with the lever in the "open" position—whatever you may desire that position to be.

Drilling the central hole is the last job. Put a short stub of brass rod in the chuck and drill and tap it $\frac{3}{16}$ in. $\times$ 40. Screw one of the unfinished cocks into the stub, leaving the longer shoulder projecting. Insert a Slocombe centre-drill in the tailstock chuck and cut the coned recess for the union nipple by feeding the centre drill in to a sufficient depth. Finish by drilling right through both the body and the plug with a $\frac{1}{16}$-in. drill. This size, by the way, is the maximum permissible size for the through-hole, and a slightly smaller size is advisable if otherwise suitable.



Chucking fixture—mild-steel



Special nut holding taper plugs in fixture

QUERIES AND REPLIES

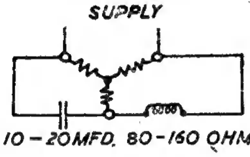
"THE M.E." FREE ADVICE SERVICE. Queries from readers on matters connected with model engineering are replied to by post as promptly as possible. If considered of general interest the query and reply may also be published on this page. The following rules must, however, be complied with:
(1) Queries must be of a practical nature on subjects within the scope of this journal.
(2) Only queries which admit of a reasonably brief reply can be dealt with.
(3) Queries should not be sent under the same cover as any other communication.
(4) Queries involving the buying, selling, or valuation of models or equipment, or hypothetical queries such as examination questions, cannot be answered.
(5) A stamped addressed envelope must accompany each query.
(6) Envelopes must be marked "Query" and be addressed to THE MODEL ENGINEER, 19-20, Noel Street, London, W.1.

Running a 3-Phase Motor

I have a 1/40 h.p., 50-volt, 3-phase electric motor, and I understand that motors of this type can be made to run on 230 volts, single-phase with the aid of a choke and a condenser. Could you please give me details of this circuit including the size of the choke and the capacity of the condenser required?

P.L.A. (W. Boro).

It is possible to operate a 3-phase motor on the lines you have in mind, but we cannot give you exact details as to the necessary values for the



condenser or resistance unless the inductance is known, so the matter must be considered as experimental. The diagram shows the usual set-up for this connection, and suggested values are given.

Equipment for Ship Modelling

On page 18 of "Model Ships and Power Boats" for February, 1950, is an article entitled an Icelandic Ship Model Maker, and in the article you use the words: ". . . does not use modern tools, but uses principally the ordinary pocket knife and a few files and rasps."

I have constructed a coaster from Underhill's drawing, and am now half-way through a model of the "Circassia," also from Underhill's drawings, and when complete propose to start on the "Edinburgh Castle." My models are waterline models only, with solid wooden hulls, all the upper works being constructed of strip wood of various thicknesses, and I use the few tools mentioned above. I am in a position, if necessary, to fit up a small workshop, and if I may quote from the article again, will you kindly inform me what you mean by "modern tools"?

I shall appreciate any suggestions you can make giving me a detailed list of the necessary tools which you advise in connection with this particular hobby. I do not make or fit any models with engines, and have no intention of doing so.

W.M.R.L. (Nottingham).

There are a number of power-driven machines which can be of considerable assistance in ship modelling. One of the most notable is the Myford ML.8 wood-turning lathe. This is fitted with a number of attachments such as saw bench, sanders, etc., which are sometimes very useful. The fret saw machine, whether treadle or motor-driven, is a useful asset, especially when fitted with a tilting table, enabling cuts to be made at a predetermined angle. A number of small motors are now available, and the workshop can often be so arranged that one motor operates a number of machines. The Coronet people also make a number of appliances. You would find examples of these machines at Tyzacks, 341-345, Old Street, E.C.1, and Buck & Ryan Ltd., 310-312, Euston Road, London, N.W.1. A small sensitive drilling machine is also a valuable asset.

Speaking generally, the ship modeller does not use many power-driven tools unless he fits engines to his models, but a carefully chosen range of machine tools can undoubtedly eliminate drudgery and improve the quality of one's work.

Tailstock Operation

I am building a modified tailstock for my Harrison 4½ in. lathe, in which it is proposed to incorporate both screw and rack and pinion operation of the barrel, with arrangements to disconnect whichever mechanism is not in use.

The screw operation will be by 10 t.p.i. Acme form thread, cut on the tail end of the barrel in the usual way, and the rack and pinion movement will be by rack teeth cut on the barrel.

As the rack teeth may encroach on part of the screw thread, is there any standard gear tooth pitch which will mesh with a 10 t.p.i. screw, avoiding deformation of the thread by the rack? It is not proposed to cut skew teeth on the pinion to match the thread angle, because of the torsional effect on the barrel.

What would you suggest is a suitable number of teeth for the pinion, meshing with 1/10 in. pitch rack, to give suitable leverage on the barrel?

W.T.B. (Slinford).

The usual practice when making provision for either screw or rack and pinion operation, is to provide two tailstock barrels, one being screwed and the other having a rack cut upon it.

It is possible to cut a rack to a circumferential pitch, and also a pinion to suit, so that the teeth of the rack would correspond in pitch to the thread on the barrel, but this could not be done with standard gear cutters, and in any case, it would be extremely difficult to avoid some interference between the square-cut rack teeth and the angular disposition of the threads, unless the rack was undercut below the thread diameter.

An alternative method, which would be quite satisfactory, would be to cut the pinion in the form of a worm wheel to engage with the tailstock barrel threads. You state that you object to racking on the thread because of the torsional effect on the barrel, but this would be negligible owing to the small angle of the thread.

We do not recommend using less than 12 teeth for the pinion in order to get smooth working, and this would also give a reasonably good leverage on the barrel.

The "M.E." Cine Projector

I understand that it is possible to obtain drawings, etc. of the "M.E." 16-mm. projector from you as the publishers, and I would be glad to know the price of these and also information as to where castings and other components of this projector can be obtained.

W.L.S. (Bowdon).

We are unable to supply drawings of this at present, as our stocks of original drawings were completely destroyed by enemy action during the war.

It is, however, possible to obtain drawings, also castings and parts for constructing the projector, from Roox Products, Wellhouse Road, Beech, Alton, Hants.

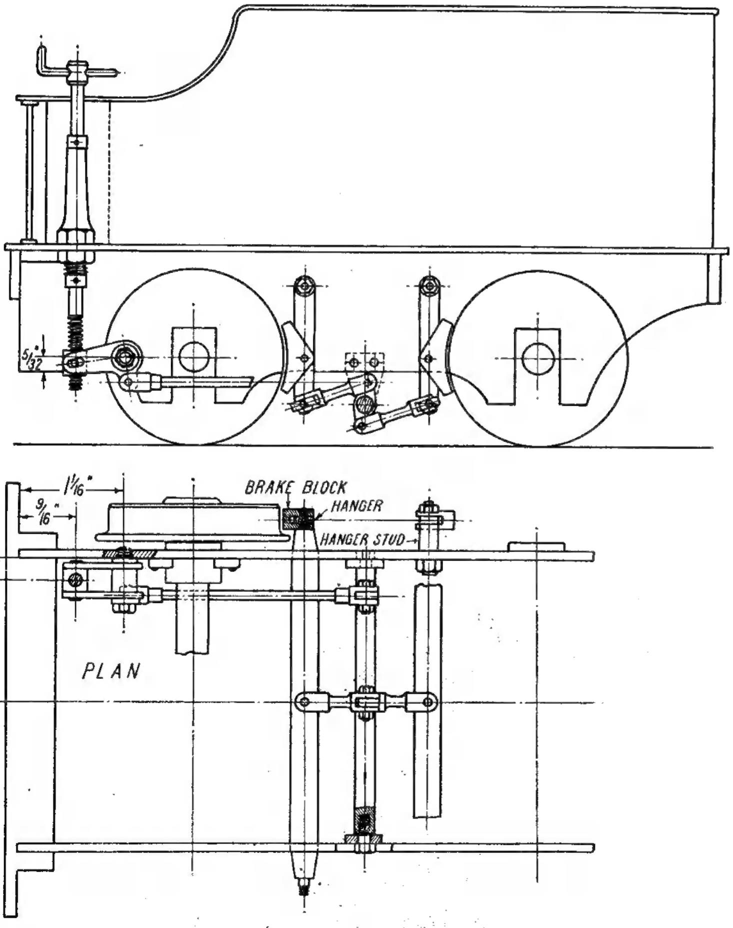
L.B.S.C.'s "Canterbury Lamb" in $3\frac{1}{2}$ in. Gauge

● THE TENDER BRAKE GEAR

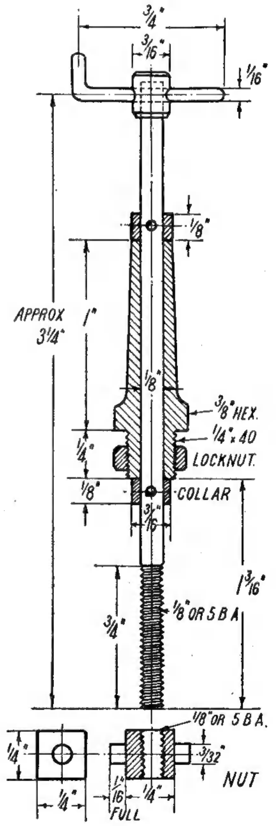
WHEN scheming out the tender brake gear for *Invicta*, my first thought was to make a really ancient job of it, with outside rods and wooden brake blocks; but second thoughts decided on a simple mixture of "ancient and modern," as with the engine part. She therefore has the usual iron blocks, with plain hangers, but they are actuated by a double-armed lever, as used on wagons. The brake column is of the screw-and-nut type, used since the "year dot." The complete doings is shown in the elevation and plan, reproduced here; and the parts are easy to make and erect, so there is no need to spend a lot of time writing useless rigmarole, and we'll get to business right away.

For the brake column, saw or part off a piece of $\frac{3}{8}$-in. hexagon rod to $1\frac{1}{4}$ in. full length. Chuck in three-jaw, face the end, turn down $\frac{1}{4}$ in. length to $\frac{1}{4}$ in. diameter, and screw $\frac{1}{4}$ in. $\times$ 40. Centre, and drill right through with No. 30 drill. Chuck the screwed end in a tapped bush held in three-jaw, and turn the body taper as shown, facing the end off square. If the lathe is a bit wibbly-wobbly, bring up the back centre for support, whilst turning the taper. Make a $\frac{1}{4}$ in. $\times$ 40 locknut from a $\frac{1}{8}$ in. slice of the $\frac{3}{8}$-in. hexagon rod; also two collars, to prevent end movement of the spindle. These are just $\frac{1}{8}$ in. slices parted off a bit of $\frac{3}{16}$ in. rod which has had a $\frac{1}{8}$-in. hole drilled in the end.

The spindle is a $3\frac{1}{4}$ in. length of $\frac{1}{8}$-in. steel rod, with $\frac{3}{4}$ in. of $\frac{1}{8}$-in. or 5-B.A. thread put on one end, by aid of a tailstock dieholder. To make the handle, chuck a piece of



Elevation and plan of brake gear



Brake column assembly

$\frac{3}{16}$-in. rod in the three-jaw, face and slightly chamfer the end, centre, and drill a No. 32 hole in it, $\frac{3}{16}$ in. deep. Part off at $\frac{1}{4}$ in. from the end. Drive this on to the blank end of the spindle ; then chuck the spindle, and face off and chamfer the boss. Drill a No. 53 hole through boss and spindle, squeeze in a bit of $\frac{1}{16}$-in. silver-steel, bend up one end to give the fireman something to grab when he wants to " plonk 'em on quick," and round off the ends, or you'll get well and truly ticked off if he cuts his hand on a sharp edge. Put one of the collars on the spindle, so that the underside of it is $\frac{5}{8}$ in. below the boss of the handle, and pin it with a bit of steel wire ; poke the spindle through the column, put on the other collar, and pin it so that there is just the weeniest bit of end movement. Just enough to allow the spindle to turn freely, and no more. Put a spot of oil on the spindle before pinning the collar. The position of the hole for the brake column had best be marked off from the underside ; don't forget it is the *left-hand* front corner when the tender is upside down ! Mark a point $\frac{9}{16}$ in. from the back of the drag beam, and 7/32 in. from the inside of the frame, and drill a $\frac{1}{4}$ in. hole at that place. File off any

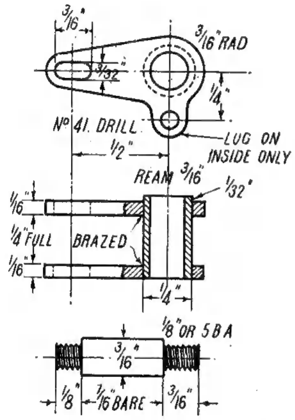
as the pull-rod arm can be combined with the actuating arms, and the whole issue mounted on a stud. Cut the arms from $\frac{1}{16}$-in. steel ; one as shown, with the bottom lug on it, and one without any lug. To form the slot, drill two 3/32 in. holes at 3/32 in. centres, and remove the surplus metal between, with a rat-tail file. Drill a $\frac{3}{16}$-in. pilot hole first, in the larger end, and open out to correct size, otherwise you'll get a polysided hole. Chuck a bit of $\frac{1}{4}$ in. round steel in three-jaw, face the end, centre, drill down about $\frac{7}{16}$ in. depth with No. 14 drill, and part off at 13/32 in. from the end. Squeeze the arm without the lug on to one end of the bush, and let it project 1/32 in. as shown.

Before squeezing on the other arm, the brake nut must be made. Chuck a piece of $\frac{1}{4}$-in. square rod—bronze for preference, but steel may be used—truly, in the four-jaw. Face the end, and turn down a full $\frac{1}{16}$ in. length to 3/32 in. diameter. Part off at $\frac{5}{16}$ in. full from the shoulder ; reverse in chuck, and turn a similar pip on the opposite end. Drill a No. 40 hole right through, between the pips, and tap it $\frac{1}{8}$ in. or 5 B.A. to match the thread on the brake spindle. It is a good wheeze to hold the nut in the four-

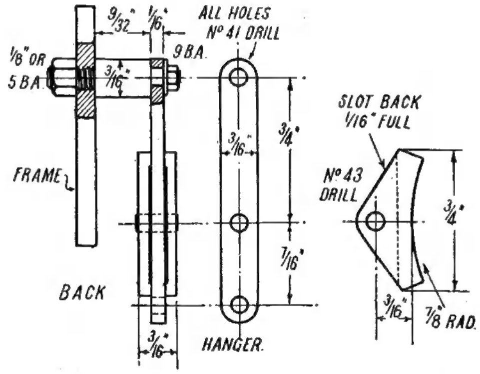
beam, drill a No. 40 hole, and tap it $\frac{1}{8}$ in. or 5 B.A. to match the stud. Countersink on the outside of frame ; screw the shorter end of the stud in tightly, and rivet it over into the countersink, filing off flush. Temporarily remove the brake spindle ; put the arm-and-nut assembly on the stud (don't forget a drop of oil) and secure it with a commercial nut and washer. The bush should be free to move on the stud, without being slack. Now replace the brake column, screwing the end of the spindle through the nut, as shown in the elevation.

Brake Blocks and Hangers

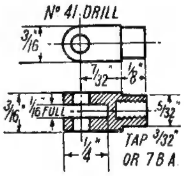
The hangers are simply strips of $\frac{1}{16}$ in. $\times$ $\frac{3}{16}$ in. steel, rounded off at the ends and drilled as shown. Our approved advertisers will probably supply cast-iron brake blocks, as they have already done for other engines in this series ; and all they will need, will be drilling for pins, and maybe the slots cleaning out to fit on the hangers. The blocks can also be cut from $\frac{3}{16}$-in. steel, in the manner fully described for *Tich*. They are pinned to the hangers with little bits of 3/32-in. silver-steel, and should be just tight enough to allow them to bed to the wheel treads when the brakes are on,



Brake arm and stud



Brake block, hanger and stud



Pull-rod fork

burr, put the screwed part of the brake column through it, and secure it with the locknut, which should just touch the top part of the beam, as shown in the elevation. Hold the nut still, and turn the column, when erecting.

Brake Arm and Nut

With the arrangement of brake gear shown, there is no need for a long cross shaft to carry the arms,

jaw whilst doing this job, so that the hole goes through truly. When squeezing the other arm on the bush, put the nut between, with the pips entering the slots. Then braze or silver-solder the arms to the bush ; quench in water only, and clean up. Ream the bush $\frac{3}{16}$ in.

Turn up a stud from $\frac{3}{16}$-in. round steel rod, as shown. Now, at 5/32 in. from the bottom edge of the frame, and $1\frac{1}{16}$ in. behind the drag

keeping the same position on the hangers when the brakes are off, to avoid rubbing on the wheel treads when the engine is running. The studs supporting the hangers are turned up from $\frac{3}{16}$-in. round steel. One end is turned to $\frac{1}{8}$ in. diameter, and screwed $\frac{1}{8}$ in. or 5 B.A. ; this end goes through the hole already in the frame, and is secured by a nut. At 9/32 in. from the shoulder, there is a plain part 3/32 in. diameter and

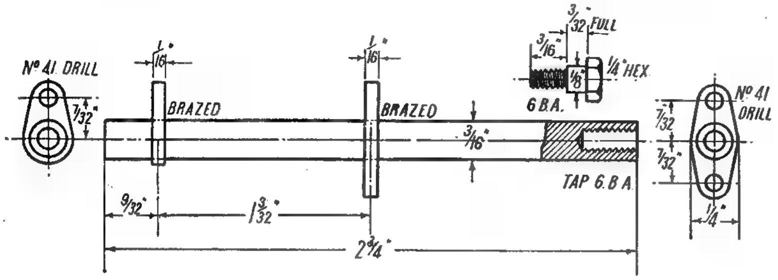
a full $\frac{1}{16}$ in. long, to carry the hanger. Outside of that, the end of the stud is reduced to 5/64 in. diameter, and screwed 9 B.A. for the nut and washer for retaining the hanger in place. The whole bag of tricks is shown in the detail sketches.

Cross Shaft and Beams

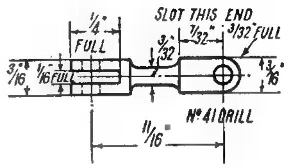
The cross shaft is a piece of $\frac{3}{16}$-in. round mild steel $2\frac{3}{4}$ in. long, both shaft between the brackets, with the single arm on the same side as the brake column, and screw home the pins through the holes in the brackets. The shaft should be quite free to turn.

The brake beams are made from two pieces of $\frac{1}{4}$ in. × 3/32 in. steel, each $4\frac{1}{16}$ in. long. Chuck truly in four-jaw, turn down $\frac{3}{16}$ in. length to 3/32 in. diameter, further reduce a bare $\frac{1}{8}$ in. to 5/64 in. diameter, and trouble of reducing the ends to a smaller diameter, for the sake of using smaller nuts. They didn't bother much about that sort of antic, anyhow, in the days when the old lady was a giddy flapper !

All that remains to be done in the way of erection, is to put the ends of the brake beams through the bottom holes in the hangers, securing them with 9-B.A. commercial nuts



Brake shaft



Connecting forks

ends being squared off truly in the lathe. Centre each end, whilst still in the chuck ; drill a No. 44 hole to a depth of $\frac{3}{16}$ in. or so, and tap 6 B.A. Tip for beginners : the deeper you drill, the less likelihood there is of breaking the tap. Next to choked flutes, the most prolific cause of mortality among the tap fraternity is bottoming unexpectedly in a blind hole. Being just an ordinary human being—as far as doing a job is concerned, anyway !—I have occasionally broken a tap. Considering the speed at which I have to work, to get anything done at all, it is a wonder I haven't had to take out a season-ticket between my home and the tap factory. Anyway, I have reground my casualties, and keep them for tapping shallow blind holes; vot you tink, eh ? Hoots, mon, awa' wi' ye !

The two arms on the cross shaft are cut from $\frac{1}{4}$ in. × $\frac{1}{16}$ in. steel strip, to the dimensions given in the illustration, the holes for the shaft being reamed, so that the arms are tight enough to "stay put" on the shaft whilst being brazed or silver-soldered. If you line them up by eye, it will be plenty good enough. The shaft goes between the two brackets already on the frames, and is retained in place by two pins. These are turned from $\frac{1}{4}$-in. hexagon steel rod, as shown in the illustration. Just chuck the rod in the three-jaw, turn down a bare $\frac{5}{16}$ in. length to $\frac{1}{8}$ in. diameter, further reduce $\frac{3}{16}$ in. length to 7/64 in. diameter, and screw 6 B.A. Part off at 3/32 in. from the shoulder ; reverse in chuck, and chamfer the hexagon. Hold the screw 9 B.A. Drill a No. 41 hole in the middle of each, and taper off the ends as shown, with a file.

Connecting Forks, and Erection

The connections between the brake shaft and the beams being so short, they can be made in one piece, instead of two forks joined by rods. Each needs a piece of $\frac{3}{16}$ in. square rod, a full $\frac{7}{8}$ in. long. Drill two No. 41 holes through each, at $\frac{11}{16}$ in. centres ; but note—the holes are at right-angles, as shown in the illustration. Slot one end $\frac{1}{16}$ in. full, and the other end 3/32 in. full, also at right-angles, for a full $\frac{1}{4}$ in. depth. Round off the ends ; slotting and rounding off being done as described for valve-gear parts. The centre part, between the forks, can be reduced to 3/32 in. diameter, for appearance's sake, the fork at one end being held truly in the four-jaw, with a bit of packing between the jaws of the fork to prevent the chuck jaws crushing them in.

The pull-rod between the brake arm below the column, and the cross shaft, is of the usual pattern, a 3/32-in. rod with a fork screwed on at each end. These are the same as I have described goodness-knows-how-many-times, for valve gears and so on, so I don't need to repeat instructions here ; the little detail drawing gives the necessary dimensions. The completed pull-rod should be approximately $2\frac{7}{16}$ in. between centres of pinholes. The pins can be made from little bits of 3/32-in. silver-steel, screwed and nutted at both ends ; they are out of sight, so there is no need to go to the and washers. Don't strain the hangers ; take one off each side, to get the beams in. Then slide the 3/32 in. slot of the connecting-piece over the beam, and fix it with a 3/32-in. bolt. These bolts should be made long enough to enable them to be turned by finger pressure when the nuts are home at the ends of the threads ; otherwise they will pinch in the jaws of the forks. The other ends of the connecting-pieces go over the ends of the double-armed lever, as shown in the illustrations, and are secured in similar manner. One end of the pull-rod is attached to the single-armed lever on the brake shaft, and the other end to the lug under the actuating arm at the bottom of the brake column. A bolt in each of these forks, finishes the job. With the aid of a spot of oil on each joint, and on the nut and screw, the brake should operate easily by turning the handle. Warning—the brake is useless for stopping purposes, as the tender is too light to be effective. It is merely for show, although it works, but can be used to prevent the engine accidentally moving, when left standing with steam up. As the parts are so very light, use a little discretion when twisting the brake handle !

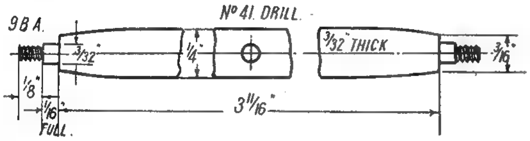
Tender Steps

The tender steps are very old-fashioned, a relic of stage-coach days, and frequently to be seen on ancient locomotives. The side supports are bent up from 16-gauge steel wire, which is fairly stiff, and won't look clumsy. The two sides look like a pair of earwig's "pliers" when

placed together with the step (a bit of 16-gauge steel) between them. If preferred, the lower end can be a complete loop, with no separate flat step, like a horse-rider's stirrup; and the upper step can be a bit of 16-gauge wire, fitted between the sides, like the step of a ladder. Please your good selves! A bit of angle, which can be bent up in the bench vice, is attached to the upper end, all joints being silver-soldered. The complete gadget is attached to the underside of the tender soleplate, close to the drag beam, by a couple of countersunk screws, nutted underneath, as shown in the illustration.

Drawbar and Coupling Chain

The drawbar hook is filed up from a bit of 1/8 in. × 3/8 in. flat steel, to the shape and size shown. Don't forget to round off all sharp corners! Directly behind the hook, the stem is filed square, for about 1/4 in. length, to prevent the hook from turning when pulled out a little when starting a heavy load. The extreme end is reduced to 3/32 in. diameter, and



Brake beams

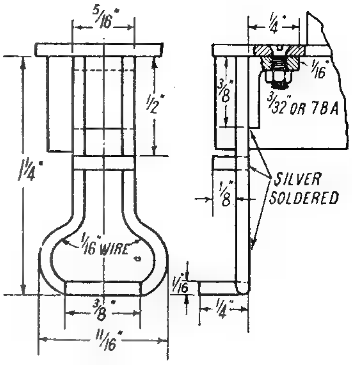
screwed, to take a nut and washer for holding the spring in place. The spring should be about half compressed, when the drawbar is right home as shown; if it has no initial compression, the hook will pull right out as far as it will go, when the throttle is opened, and cause a nobby jar. With 80 lb. of steam in the boiler, and all the weight available for adhesion, the little old lassie can give a far more hefty tug than most folk would deem possible. A similar but smaller hook can be fitted to the engine beam for appearance's sake, with a short stem nutted direct. There are no buffers; such things were unknown around 1830. Neither were atom bombs; happy days, they were! My granny was three years old when *Invicta* ran her first trip; her father drove a stage coach. Doesn't seem possible, does it—but it was so! She was observant, had a good memory, and in later life could give an excellent description of the engines seen in her girlhood.

The three-link coupling chain can be bent up from 1/16-in. steel wire. Make the joint of each link at the side, and braze it; otherwise they may pull open.

Coupling Between Engine and Tender

As the boiler comes close to the engine drag beam, there is no room for the stem of either a drawbar or a fork of the usual pattern; so file up a fork to the shape shown, milling out the slot to accommodate a coupling-link made from 1/8 in. × 1/4 in. flat steel rod. This is attached to the drag beam of the engine, by two 3/32-in. or 7-B.A. screws, run through clearing holes in the side wings of the fork, into tapped holes in the beam. The pin is turned from 1/8 in. round steel rod, and should be a tight push fit in the holes in the fork, to prevent it coming out when the engine is running. The coupling link is merely a piece of 1/8 in. × 1/4 in. flat steel rod, with two 9/64-in. holes drilled in it at 13/16 in. centres, and the ends rounded off as shown. Countersink the holes slightly to make it easier to insert the pins.

Make a lug from 1/8 in. × 1/4 in. flat steel, similar to those I describe for smokebox doors. Chuck truly in four-jaw, turn a 3/32-in. pip on the end, and screw it as shown. Part off at 5/16 in. from the shoulder, round the end, and drill a No. 30 hole in it. In the centre of the drag beam, just underneath the drawbar slot, drill a No. 48 hole, and tap it to suit the screwed pip on the lug. Screw in the lug from the back of the beam, then put the No. 30 drill through it (with the tender upside down on the bench, or drill table) and drill through the top angle and the soleplate, filing off any

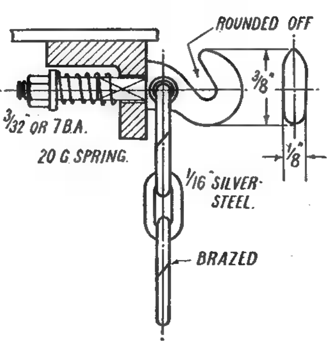


Details of foot steps

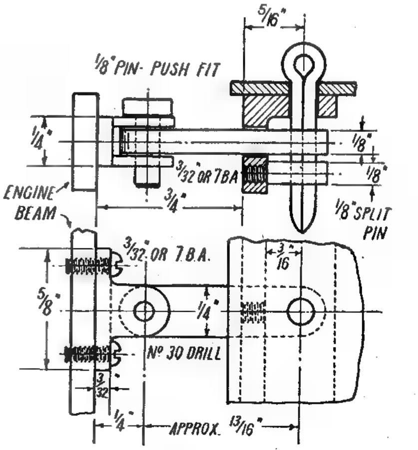
burrs. When coupling the engine and tender, push the end of the link in the drawbar slot, and poke an ordinary 1/8-in. commercial split pin through the lot, as shown. If you drop a pin in long grass, just get another—it saves time! The link never need be disconnected from the fork on the engine drag beam. That finishes the construction of the ancient and honourable old maiden, and I hope the job has been a congenial one. With average workmanship, she should haul a living load with far less exertion than old *Rainhill*; be trouble-free, and run for a very long time ere she needs any repair or replacement.

Epilogue

I haven't the foggiest notion what the colour of the full-sized engine was, on the day she made history. At the moment she is well plastered with rust-resisting paint, which is reddish-brown when freshly put on;



Details of drawhook and chain



Engine and tender coupling

so that is nothing to go by. I would suggest that olive green, with black bands and fine red lining, would set the old girl off very well, with as much bright brass and steel as you fancy. The copper steam and exhaust pipes should also be polished ; they will turn a pretty colour when they get hot. Our approved advertisers will probably be able to supply transfer letters for the tender ; but anyway, block letters can easily be put on with a ruling pen, or cut from thin sheet metal and soldered on. Regarding the prancing horse, our Scottish friend Wilwau has already done the needful, by casting brass gee-gees which can be soldered to the tank sides and polished up ; I fancy Reeves will also do them. Warning to married readers—if you buy these castings to adorn your tender, you had better get *three* or more, because one of them, silver-plated, with a pin on the back, makes a jolly fine brooch of unusual pattern, and your wives and daughters may get ideas into their heads !

A quick way of painting the engine is to give it a good wash in petrol (outdoors !) to remove all the oil and grease, and then give it a coat of "Valspar," which needs no undercoating, and dries very quickly. My good friend, Frank Cook, of Leeds, who has painted more locomotives (and boy ! *can* he paint them) than anybody else I ever knew, says that if the glossy surface is rubbed down to a matt surface with fine abrasive paper, lining can be easily and quickly put on with an ordinary ruling pen, provided that the colour is thinned down to a consistency that will run like drawing ink. This, of course, needs a final coat of varnish, to make the job bobby-dazzle, as the L.B. & S.C. Railway cleaner boys used to say.

As to operation, the little engine needs no different handling than her modern sisters. Cover the grate with charcoal wetted with paraffin, and use an auxiliary blower to create a draught to start the fire ; or disconnect the hand-pump union, and blow air into the boiler by aid of a tyre pump and adapter, so that the engine's own blower can be used. In the latter case, don't have more than half-a-glass of water, or you'll blow water from the chimney ; and, incidentally, keep the water about halfway up the gauge, when the engine is running. Careful regulation of the bypass valve will do the needful. As there is no dome, and the boiler is small, priming will occur with too high a water level ; so it will, if you open the regulator too much, or too suddenly, when starting away. Don't have too thick a fire, or you'll choke the draught, and the steam pressure will fall ; the small boiler is a very fast steamer, but as it doesn't hold much water, it is readily susceptible to any changes in firebox temperature. A thin bright fire, replenished a little at a time and as often as required, will keep the gauge needle where it belongs, under any conditions of service. To all *Invicta* builders—many hours of pleasurable running !

BORING COUPLING-RODS

QUITE often, builders of model locomotives have difficulty in boring coupling-rod crankpin holes to exactly the same centres as the axles. The following is a description of a simple but accurate method of boring the holes.

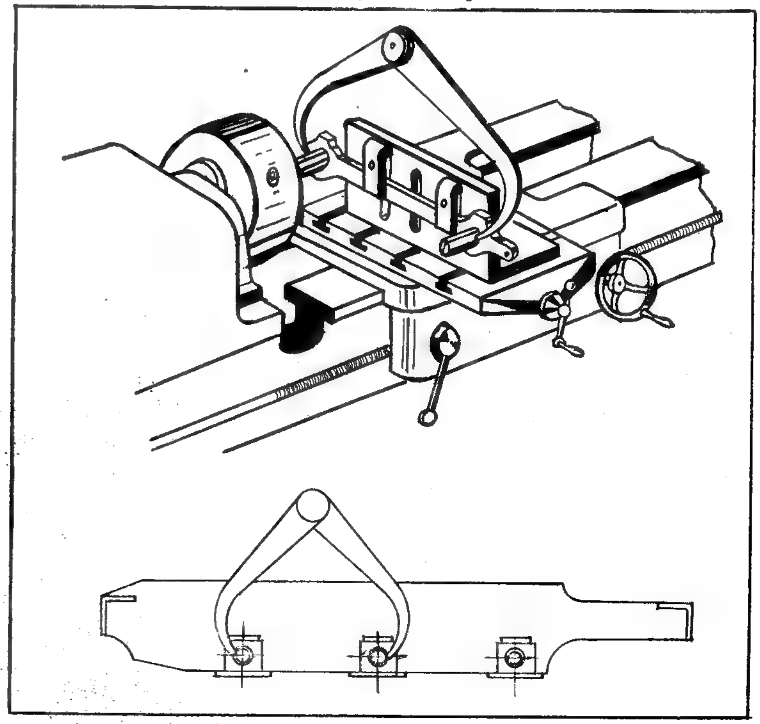
After roughing out the coupling-rods, bore the holes for the middle crankpin as marked out and then turn a stepped pin, the major diameter being the diameter of the axle wheel seats and minor diameter a nice push fit in the hole in the coupling-rod. Turn another pin to the diameter of the wheel seats and leave in the lathe chuck. Mount an angle-plate squarely on the lathe saddle and clamp the coupling-rod to the angle-plate, making sure that the centre-pop used for marking-out purposes is at exact centre height. Advance the saddle towards the headstock until the coupling-rod is just touching the pin in the chuck. We now have in effect two dummy axles that only require to be adjusted to the correct centres.

Insert the axles together with the axleboxes in the frames and caliper over the wheel seats corresponding to the coupling-rod set up on the angle-plate. Now, using this caliper setting, adjust the lathe cross-slide, calipering over the two pins.

Remove the chuck from the lathe without disturbing the pin in the chuck or the setting of the cross-slide and drill, and ream the coupling-rod hole with the drill chuck in the headstock spindle.

Repeat the process for the other holes, making sure that the correct pair of wheel seats are calipered for the corresponding pair of holes.

The above method can also be used for correcting holes which have previously been bored out of truth by using a boring tool in the four-jaw chuck, adjusting the cut by the chuck jaws.—J. BENN.



BRITISH CRAMPTON LOCOMOTIVES

By E. W. TWINING

PART 4

THE next engine to be dealt with, taking the Cramptons in order of date of construction, is that most famous and most powerful of them all, the *Liverpool*, built at the works of Messrs. Bury, Curtis and Kennedy, of Liverpool for—like Tulk and Ley's *London*—the Southern Division of the North Western Rly.

As the writer thinks it extremely likely that this engine will prove the most popular of the Cramptons amongst model makers, and as he has the necessary data available to enable him to do so, he proposes to give a full description of the engine and to prepare drawings showing, in addition to external elevations, cross sections, a longitudinal section giving details of the boiler, plan views and drawings of the tender. These will all follow in due order; but in this present contribution only external elevations are presented: the side in Fig. 8 and front and rear views in Fig. 9, sufficient, however, for the purposes of an historical survey of British built Cramptons.

The *Liverpool* was delivered from Bury's works in 1848 and was stationed principally at Wolverton, where the Southern Division locomotive works were situated; roughly midway between Euston and Birmingham. The engine worked the traffic chiefly between London and Rugby. In 1851 the *Liverpool* was temporarily withdrawn from service and sent

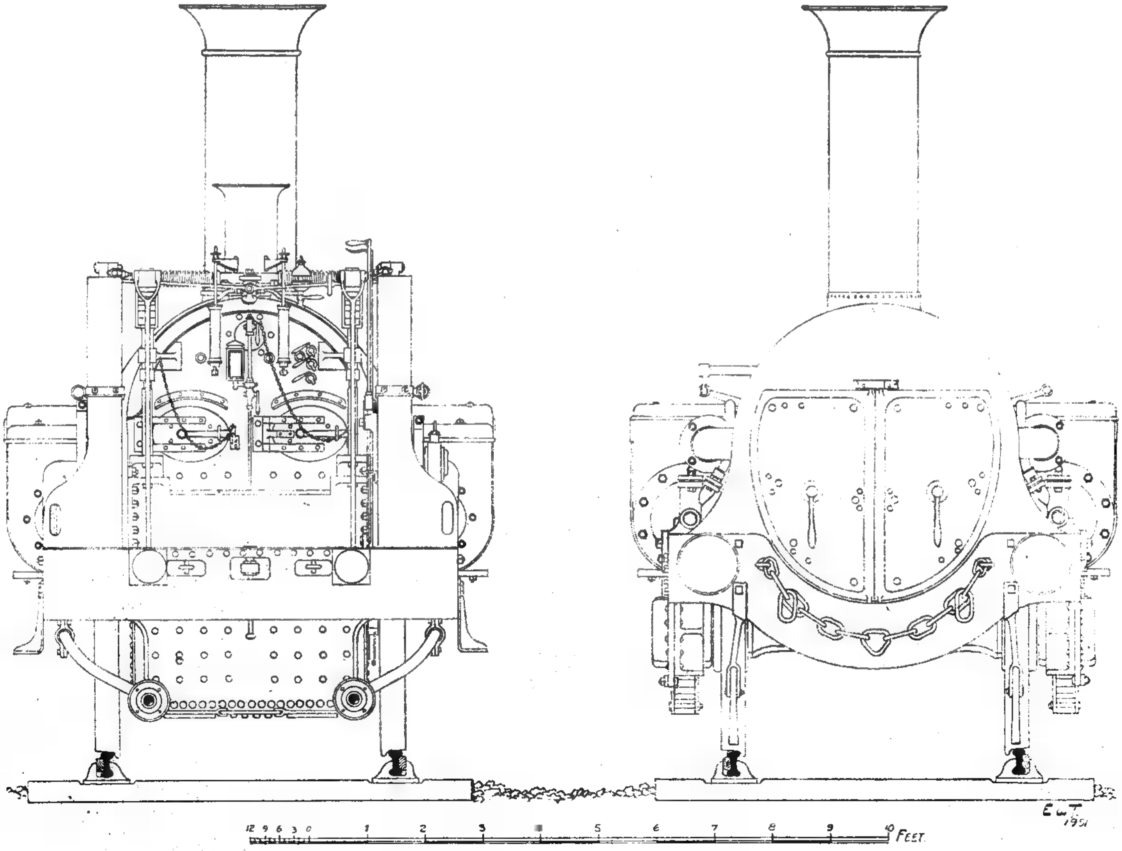


Fig. 9. Crampton's "Liverpool," 1848. Back and front elevations

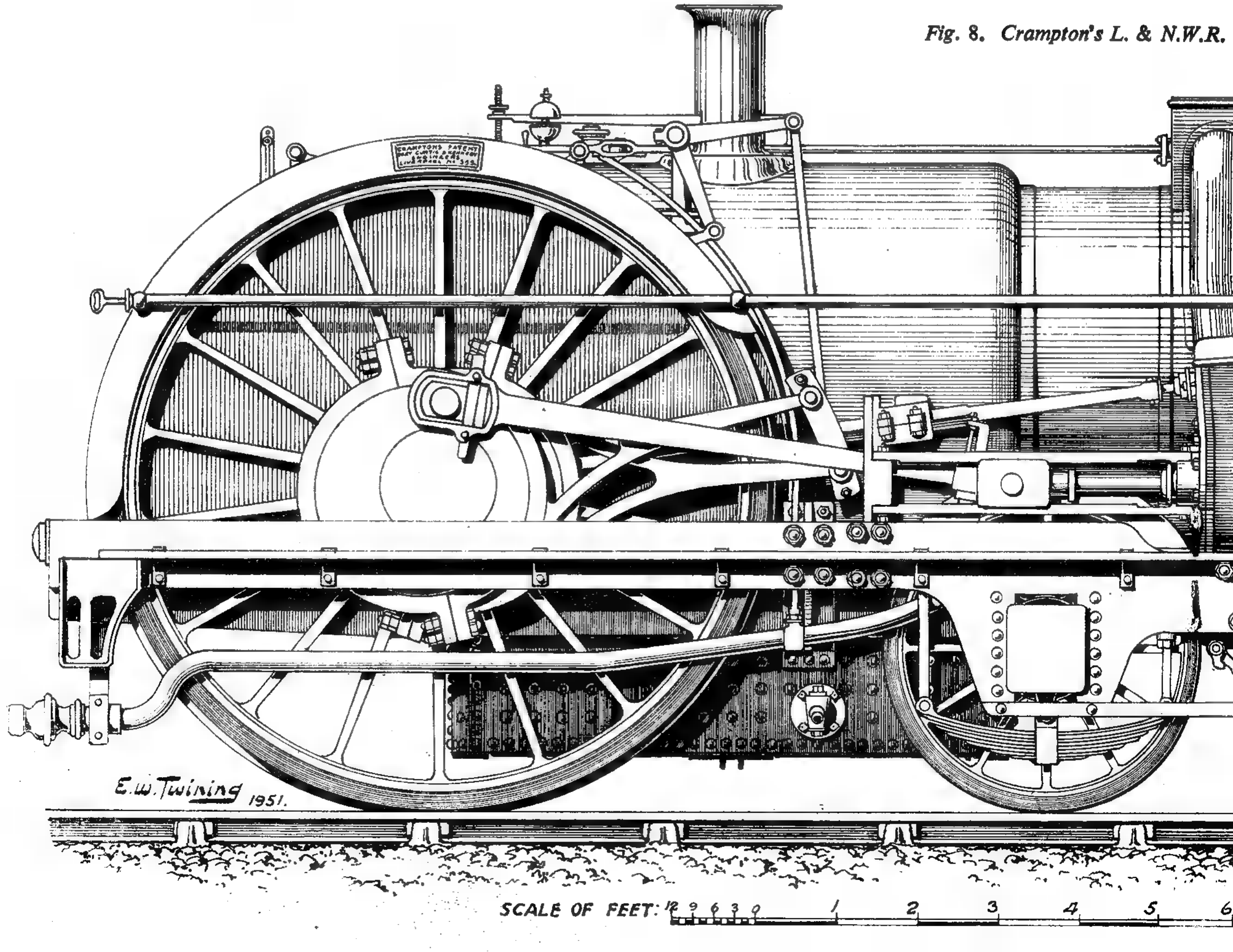
to the Great Exhibition in Hyde Park.

It would appear that the chief initiative reason for the design by Crampton and the ordering of it by the North Western Railway, was not that such an enormous engine was really necessary, but because the company's rivals, the Great Western were building, for their broad gauge, engines which in power, speed and performance completely eclipsed anything which could be attained on the narrow gauge. So, Crampton designed his "ultimatum," as it was thought to be, with driving wheels, cylinders and boiler pressure exactly the same as the biggest broad gauge express engines and with some three hundred and seventy square feet greater heating surface. In the exhibition she stood: a "Splendid Monster," as D. K. Clark called her, for everyone to compare with Daniel Gooch's 7-feet gauge *Lord of the Isles* not far away.

In the catalogue of the Great Exhibition there appeared [redacted] full-page woodcut of the *Liverpool* and this, unfortunately, has been reproducnb and otherwise copied [redacted] number of times. Warren's fine book: *A Century of Locomotive Building* contains a block made from the 1851 woodcut and the catalogue illustration has been used in recent years as a basis for perspective views. But it is not correct; indeed, in regard to certain features, it is fantastic, notably in the shape of the chimney and the circular casing over the regulator box. The woodcut shows the wooden-strip lagging on the boiler, uncovered by cleading plates and, moreover, the strips [redacted] carried forward *over the smokebox*! There are other incorrect minor details which it is perhaps superfluous to mention. Erroneous statements have, from time to time, been made regarding this engine; for instance: D. K. Clark, in *Railway Machinery*, gives the diameter of all the carrying wheels [redacted] being equal, whereas the leading pair were three inches larger; even Clark's own very excellent and accurate woodcut shows that they were larger. The writer has seen only one illustration showing all equal wheels and this appeared in E. L. Ahron's book; it is [redacted] modern drawing and the inaccuracy is obviously [redacted] draughtsman's error. Even the exhibition catalogue woodcut shows larger leading wheels.

In Tredgold's splendid work: *Locomotive Engines*, published in 1850, there is [redacted] very complete

Fig. 8. Crampton's L. & N.W.R.



specification of the *Liverpool* (it may be found on the last two pages in the book) and therein it is definitely stated that the chimney was 18 in. internal diameter and was *parallel throughout*. This matter of parallelism is specially mentioned here, because nearly every published drawing shows a tapered chimney, larger at the base than at the top.

The height of the top of the chimney above rails was 13 ft. 2 in. Through the boiler there were 292 tubes of $2\frac{3}{8}$ in. diameter, and eight of $1\frac{3}{4}$ in. diameter, 300 in all; their length was 12 ft. 6 in. The heating surface was: tubes 2136.117 sq. ft; and of the firebox, 154.434 sq. ft.; total 2290.551 ft. The grate area (44 firebars) was 21.58 sq. ft. Working pressure, 120 lb. per sq. in.

The boiler barrel was of the usual Crampton form, double segmental, the upper segment of larger diameter than the lower. At the junction, the irregularity of form was compensated for, and internal pressure taken, by a row of tie bolts of $1\frac{1}{8}$ in. diameter, spaced [illegible] in. apart, centre to centre.

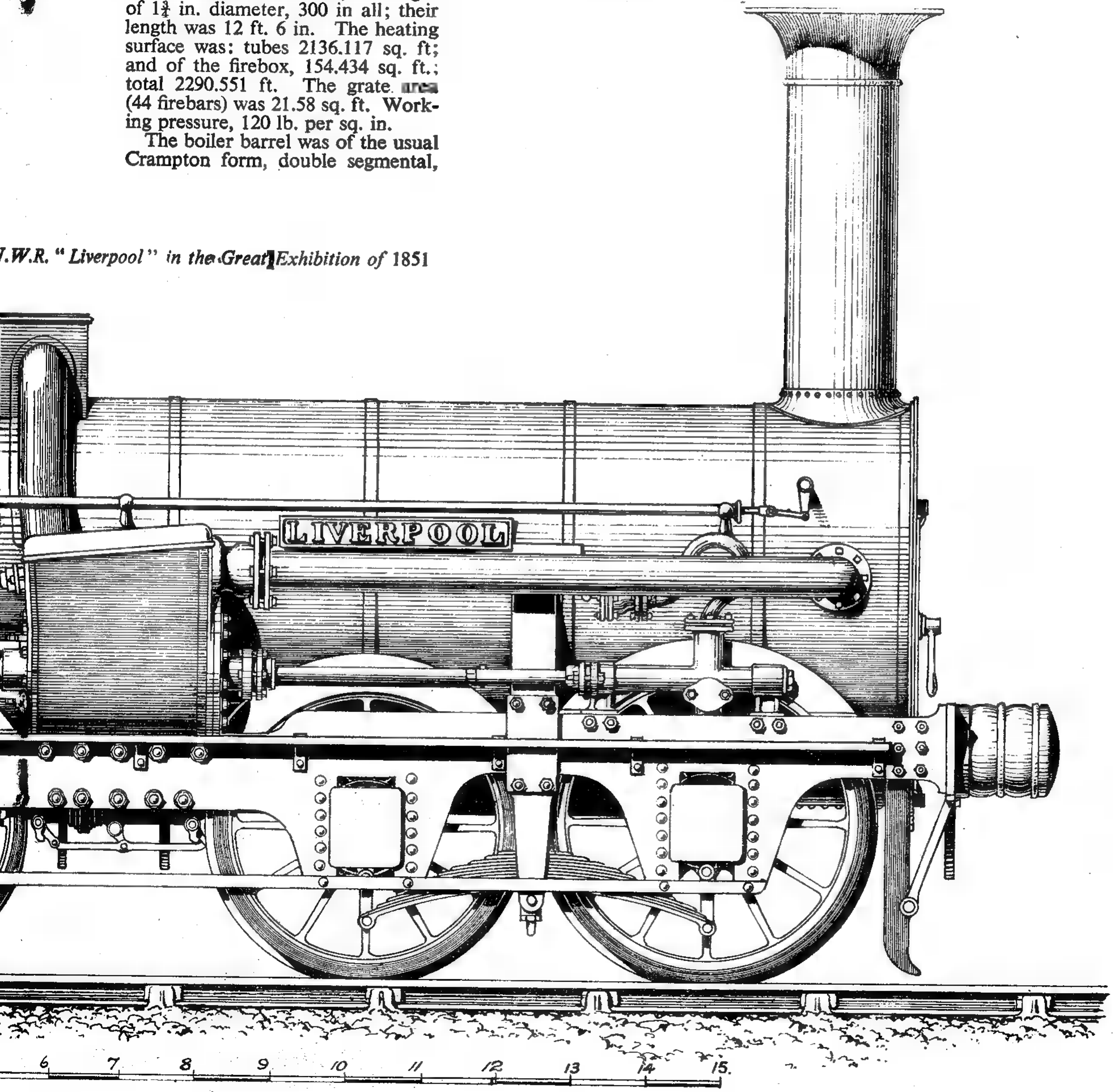
The frame plates, both inside and out, together with all transverse framing, including the buffer beams, were of $1\frac{1}{4}$ in. thickness.

The driving wheels were 8 ft. in diameter with 17 in. diameter bosses. Leading wheels 4 ft. 3 in. diameter; four intermediate wheels 4 ft. diameter. Driving axles 7 in. diameter with journals 10 in. long; other axles 6 in. diameter with 10 in. journals.

The cylinders were bored to 18 in., and the stroke 24 in. Pistons were fitted each with two cast-iron rings and the piston-rods were $2\frac{1}{2}$ in. diameter.

The main steam collecting pipe, fixed horizontally inside the boiler,

(*Continued on page* 625)

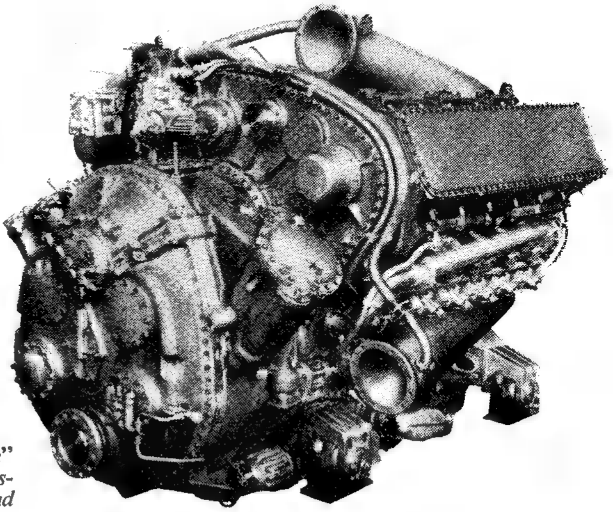


.W.R. "Liverpool" in the Great Exhibition of 1851

The Napier "Deltic" Engine

Details of a noteworthy development in the design of high efficiency internal combustion engines

By Edgar T. Westbury

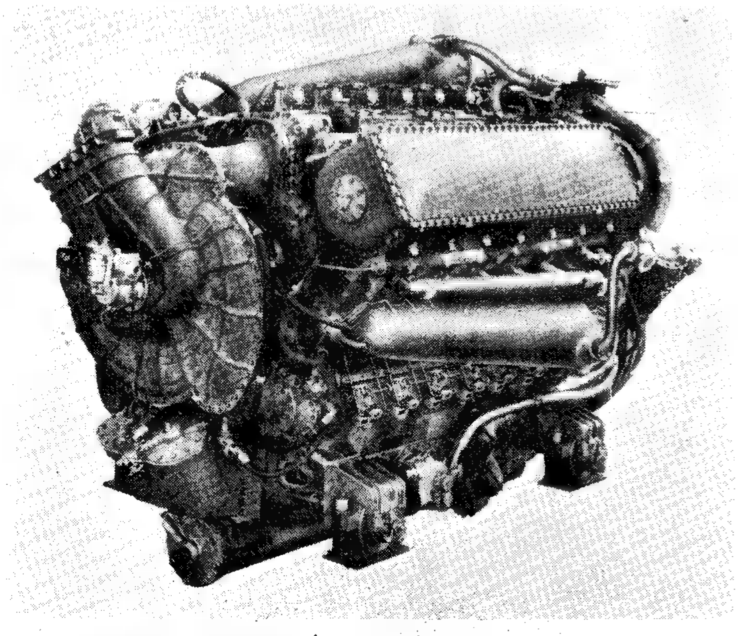


A view of the "Deltic" engine from transmission gear end

ALTHOUGH opinions may differ as to the value of articles in THE MODEL ENGINEER on the subject of "prototype" engineering, which are sometimes criticised on the grounds that they have no direct bearing on the problems of model construction, there is reason to believe that most readers do take a very keen interest in full-size engineering developments, and articles on this subject have been very popular in the past. Constructors of model locomotives, ships, aircraft, etc. can obtain not only authentic information, but also inspiration and new ideas, from a careful study of drawings, photographs and descriptions of the full-size prototype.

The case is not quite the same, however, with that problem child of the engineering family, the internal combustion engine, in which it is extremely difficult, or even impracticable, to produce a successful scale working model of the most advanced types of large engines, and superficial representations, such as are popular in the case of the other objects mentioned, hold little appeal to the constructor.

I have followed closely the development of full-size engine design, but have rarely ventured to comment upon it in these pages, because the more immediately important matter of keeping up to date with demands for information on the construction of model i.c. engines has been more than I can properly cope with. However, I have recently encountered a new type of engine which I believe to have far-reaching possibilities, and which embodies most interesting features of design, so that I feel sure there are many readers who will welcome a detailed description of it, even if there appears to be little prospect of exploiting these features in a working model. Furthermore, this gives me an excuse for writing an essay on the elements of engine design, which I hope many readers will find instructive.



Reverse view of engine, showing centrifugal scavenging blower

In company with a number of other representatives of the technical Press, I was recently privileged, by courtesy of the Chief of Naval Information, to witness an impressive demonstration of the engine in question, and also to take a cruise on an ex-enemy E-boat in which two of the engines have been installed for seagoing tests.

Contrary to views which have often been expressed lately, the introduction of the internal combustion turbine has not stopped development of the reciprocating type of engine, which for many practical reasons is likely to be with us for many years yet. The lessons of the last war have emphasised the importance of engines of high power-weight ratio for light, fast naval vessels, and the engine to be described has been developed, from basic proposals submitted by Mr. N. Penwarden, a draughtsman at the Admiralty Engineering Labora-

tory, by Messrs. D. Napier & Son, Ltd., on behalf of their parent company, the English Electric Co. Ltd. After prolonged tests, it is now in production, primarily for the purpose stated above, though it obviously has a much wider potential application, for other types of marine craft, locomotives, stationary work, and even aircraft.

The engine is of the two-stroke type, employing the opposed-piston principle, having 18 cylinders, and producing 2,500 b.h.p. A 9-cylinder version of half the power has also been produced, and the design is applicable to any multiple of three cylinders. It is designed to run on oil fuel, with solid injection and compression-ignition, but could equally well be adapted to run on gas or petrol, with normal carburation and spark ignition.

Cylinder Arrangement

The basic principle of design on which this engine depends is its particular disposition and arrangement of cylinder groups, and to understand the reason for, and the advantages of, this feature, a brief review of the way in which multi-cylinder engines have developed may be of interest. In all i.c. engines of substantial size or power, it has been found an advantage, and sometimes a necessity, to depart from the policy of developing the power in a single cylinder unit, and to duplicate or multiply the number of cylinders, operating on a single crankshaft or a system of cranks geared to a common output shaft. The reasons for this are various, and include convenience in dealing with heat and mechanical stresses, balancing, and compactness; but perhaps the most urgent practical reason is to promote smooth, even running by improving uniformity of turning moment, or as it is often technically expressed, low ratio of maximum to mean torque.

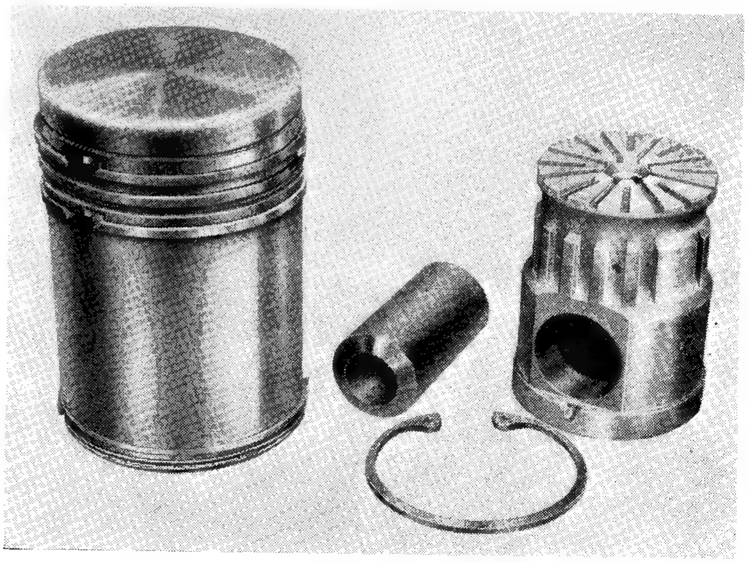
In this respect the i.c. engine differs radically from the steam engine, as in the latter case a single-cylinder double-acting engine has a frequency of power impulses, in relation to shaft revolutions, equal to that of the normal four-cylinder four-stroke i.c. engine as commonly used in motor cars, and though it is not impossible to improve upon this comparison, it is rarely convenient. Generally speaking, multiplication of cylinders of steam engines is adopted mainly for purposes of compounding or expansion staging.

Of the various cylinder arrangements, the most obvious, and most commonly employed, is to dispose them parallel and in line with each other; alternatively, they may be placed in double banks, in vee or horizontally-opposed formation; or triple-banks, as in "trident" or Y formations. The latter may be developed into star or radial formations, either in a single row or banked. More uncommon arrangements, using two or more crankshafts geared together, are the "square four," and the "H" type engine, the latter having two compact horizontally-opposed banks of cylinders one above the other. All these arrangements have their own particular virtues and limitations; for instance, the straight in-line engine is convenient to produce, and reasonably accessible, but it produces a long engine, tending to lack structural rigidity unless heavily built, if more than about four cylinders are used. Double-banked engines are stiffer in structure, and are used successfully for a larger number of cylinders, up to twelve or possibly sixteen, but are more complex and less readily accessible. Radial engines are compact in a fore-and-aft direction and enable a short, stiff crankshaft to be used, but they have a very large frontal area, and are unsuitable for most purposes outside aircraft. Incidentally, the geometry of these engines makes it desirable to use an odd number of cylinders to obtain equal firing intervals, if they are of the usual four-stroke type.

Opposed-piston Engines

Apart from the disposition of the cylinders, their individual design is another important consideration. Most four-stroke engines of high efficiency have their valves in the head, and this form of design may almost be said to have become conventionalised nowadays. Two-stroke engines have not been in favour for high power, except for heavy marine practice, but in the course of their development they have produced at least two very interesting departures in cylinder design, both of which have the unusual feature of two pistons to one combustion chamber; namely, the "split single" and the opposed-piston arrangement. The latter is not confined to two-stroke engines, but is particularly applicable to, and generally associated with them. On the face of it, the primary advantage of this arrangement is that it enables perfect dynamic balance to be obtained by the opposition of equal opposing forces at equal velocity, but it has other properties which are just as important in practice. The first is that it enables the scavenging of a port-controlled two-stroke cylinder to be vastly improved by introducing unidirectional air flow; the second is that it eliminates the fixed cylinder head, as such, the reaction thrust which this component would normally absorb being taken by a moving member. It may be observed that in the development of high power engines, the thermal and mechanical stresses on cylinder heads have often caused considerable trouble, and have given designers many headaches.

The opposed-piston engine has



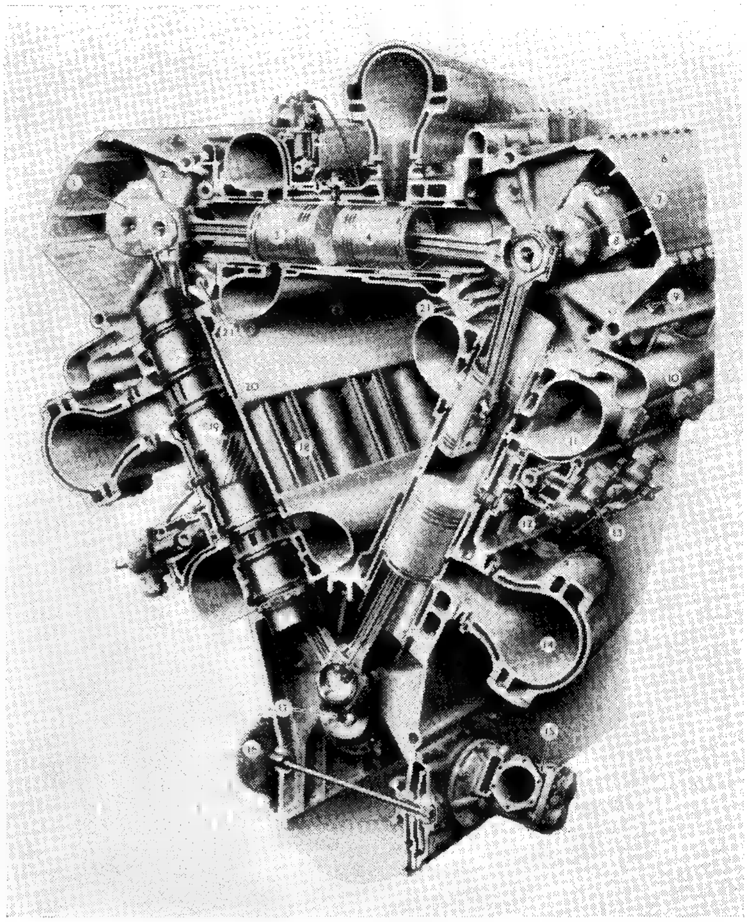
The patented oil-cooled piston

long been the dream of the inventor seeking the elusive "ideal" engine, but in spite of its undoubted advantages, it has been a difficult engine to adapt to practical requirements. It calls for either a crankshaft at each end of the cylinder block, the two being synchronised by gearing, or a cumbersome system of connecting rods; in either case it is likely to become a bulky and awkward-shaped engine. There are several well-known examples of opposed-piston engines which have been highly successful, including the Fullagar, Doxford, Oechelhauser, and Junkers, the latter having been adapted to aircraft propulsion, but it has always been a problem to build and install them compactly.

The "Deltic" Engine

In this engine, the particular virtues of the opposed-piston engine have been combined with a unique arrangement of cylinders, which enables it to be built compactly, packing a very high power into a relatively small bulk and weight, and at the same time making all working parts readily accessible for servicing. The inherent simplicity of the valveless two-stroke is retained, with its high mechanical efficiency, as the loss of power normally entailed in driving the valve gearing is eliminated. While there are no new theoretical principles involved in the design, the combination of desirable features cannot fail to impress the practical engineer; but what is more, it undoubtedly gives the desired results.

The arrangement of the working parts of the engine are clearly shown in the sectional illustration, where it will be seen that the cylinders are disposed in the form of an equilateral triangle, with three crankshafts located at the apices. Each crankpin is connected to two pistons, working in adjacent cylinders, the big end bearings being of the fork and blade type, so as to avoid geometrical errors which would arise if the articulating centres were not co-axial. The three crankshafts are geared together so as to run at the same speed, two running in one direction and the third (in practice the lower shaft) in opposition, timed in correct phase, so that the pistons alternately approach and recede from each other as the shafts rotate. One piston in each cylinder controls the inlet ports at the outer end of its stroke, and the other the exhaust ports; the pistons are not in truly opposite phase, the exhaust piston having a 20 deg. lead so that it opens and closes its ports earlier than the inlet piston. In this way



Cross-section through one bank of cylinders

Key: 1—"*BC*" *crankshaft*; 2—"*BC*" *crankcase*; 3—*Inlet piston*; 4—*Exhaust piston*; 5—*Crankcase breather*; 6—"*AB*" *crankcase*; 7—"*AB*" *crankshaft*; 8—*Main bearing cap*; 9—*Crankcase tie-bolt*; 10—*Drain oil manifold*; 11—*Air inlet gallery*; 12—"*A*" *camshaft casing*; 13—*Fuel injection pump*; 14—*Exhaust manifold*; 15—*Sea-water pump*; 16—*Fresh-water pump and pressure oil pump drive gear*; 17—"*CA*" *crankshaft*; 18—*Cylinder block tie-bolts*; 19—*Cylinder liner*; 20—"*C*" *cylinder block*; 21—*Blower flexible drive shafts*

the exhaust pressure is released before the new charge is introduced, while on the other hand the exhaust ports are closed before any substantial escape of the fresh charge can take place. The inlet ports are cut at an angle to the wall of the cylinder so that the gas enters tangentially, producing a rotary swirl which is effective in cleansing or "scavenging" the exhaust products from the cylinder.

Along each bank of cylinders, near the centre of its length, runs a camshaft which operates the fuel pumps, which are of the usual metering type, with spill ports, controlled by rotating the plungers, to inject the quantity of oil required; in this respect they follow the normal diesel engine practice, but the pumps are not made in the usual form of multi-plunger unit. Each pump is virtually a separate unit, situated as near as possible to its cylinder and delivering fuel to two injection valves of the outward-opening type, by short pipes, all of equal length.

The cylinder liners are, of course, open at each end, and are not subject to stresses in an endwise direction, so they need only to be located at one end, water seals in the form of rubber rings being provided at the other end and around the port belts. In the region of the

combustion chamber, the liners are reinforced by thickening up, and spiral passages are provided on the outside for the circulating of cooling water. The bores are chromium plated and lapped.

A patented form of piston is employed, the main object of which is to assist cooling by lubricating oil from the inside. The construction of the piston is of great interest, because somewhat similar forms of pistons have been used in model practice, though for a very different reason. It consists of two main components, the outer of which, of light alloy with an inserted ring of austenitic iron to carry the two top piston rings, is turned all over, and an inner member is fitted, having a cross hole to take the gudgeon-pin. and a system of grooves through which the oil passes to cool the inside of the piston head, being continuously replenished by fresh oil fed to the gudgeon-pin bearing by way of drilled passages through the connecting-rod. Both pistons in each cylinder are identical in shape and size, but one transmits more power than the other because of the phase difference, and therefore each crankpin is connected to one inlet and one exhaust piston in adjacent cylinders.

Scavenging Blower

Air is supplied to the inlet belts of all cylinders by a centrifugal blower of the double-entry balanced type, gear driven from one end of the engine, and coupled by flexible shafts, running at a little over five times crankshaft speed. It delivers air at about 8 lb. per sq. in., in sufficient volume to fill the cylinder displacement plus wastage, but is not normally intended to act as a supercharger in the true sense of the term.

From the structural point of view, the design of the engine is very attractive, the working stresses on each triangular unit being taken by tension bolts which extend from one crankcase to the next, through the cylinder block, which is in one piece for the complete bank of in-line cylinders in each case. Thus the entire unit is inherently strong and rigid. The engine is arranged apex downwards, which is convenient and accessible, but could be disposed in any other position, or with any alternative method of mounting, if required. A closed-circuit cooling system is provided, in which distilled water is passed through the jackets, and cooled by a heat exchanger, through which the water is circulated by a gear pump. An oil cooler is also provided. The mechanical arrangements for these and other services follow normal practice, and all auxiliary drives are taken from the transmission end of the engine.

For the purposes of marine propulsion, the engine is provided with a built-in gearbox giving forward and reverse drives, control being by means of a two-way hydraulically loaded plate clutch. The reverse gear has a lower reduction ratio than the forward gear, but in cases where it is desirable that a pair of engines should be "handed" so as to drive propellers in opposite directions, this can be done by using an alternative assembly of the gears interconnecting the three crankshafts.

Starting is effected by a combustion type starter, in which a cartridge is fired into a piston, the endwise movement of which operates a shaft through helical splines, the latter carrying a claw or face ratchet which engages with a similar member on the engine shaft. Five cartridges are carried in a rotating breech like the chambers of a revolver, and fired electrically as required, one "shot" normally being sufficient to start the engine from cold.

LEADING TECHNICAL DETAILS

Shaft Horse Power:
Maximum—2,500 at 2,000 crankshaft r.p.m.
Continuous—1,875 at 1,700 crankshaft r.p.m.

Net Dry Weight:
Engine only—8,725 lb. = 3.5 lb. per h.p.
Engine with reverse gear—10,500 lb. = 4.2 lb. per h.p.

Overall Dimensions:
Length (engine and reverse gear)—10 ft. 11 in.
Width—6 ft. 2½ in.
Height—7 ft. 1 in.

Cylinder Data:
Cylinder bore—5⅛ in.
Stroke—7¼ in.
Swept volume, total—5,384 cu. in. (88.3 litres).
Swept volume, Effective—5,300 cu. in. (86.9 litres).
Piston speed at 2,000 r.p.m.—2,416 ft. per minute.
B.M.E.P. at maximum power—91.9 lb per sq. in.

BRITISH CRAMPTON LOCOMOTIVES

(*Continued from page* 621)

was of wrought iron, 13 ft. 6 in. long and 5 in. inside diameter with a ½-in. slit along the top. The exhaust pipes, of copper, united in the smokebox at their tops to form a blast nozzle 5½ in. diameter.

Feed pumps of brass had rams of wrought iron 2¼ in. diameter; they were directly coupled to tail-rods from the main pistons.

Connecting-rods were of malleable iron fitted with brasses bored at the gudgeon pins to 3 in. and at the big ends to fit crank pins of 4½ in. diameter.

The valve gear was Stephenson's link motion, driven by Crampton's patented large eccentrics, the sheaves of which had a diameter of 2 ft. 9 in. In these sheaves the main crank pin was secured.

Buffers were of leather well stuffed with curled horsehair. Between centres they were spaced 5 ft. 9 in. apart and the height of centres above rails was 3 ft. 3 in. These buffers, unlike some others of the cushion type, were fitted with a guide spindle which worked in a bush in the buffer beam.

The side footplating, which extended nearly to the front of the engine, was bolted, by brackets to the faces of the outside frames and were 6 in. wide.

The barrel of the boiler, cylinders and branch steam pipes (between the regulator-box and the valve-chests) were covered with a coating of hair felt, lagged with timber and lined over all with sheet iron of No. 17 wire gauge, secured with proper hoops, bolts and nuts. The outside of the firebox was also covered with felt and lined with the same thickness of sheet iron (there was apparently no battens of timber here).

The foregoing statement of salient facts has all been carefully extracted from the specification in Tredgold. In addition, it should be mentioned that the weight of the engine, in working order, was about 35 tons.

Tredgold's fine work includes, along with those of a number of other engines, some most beautiful plates of the *Liverpool*, printed from fine engravings on copper, by W. A. Beever; these show every detail of construction of the engine to scale. So meticulously accurate are they as working drawings, each agreeing with every other, that the whole bears the stamp of mechanical truth and corroborate perfectly the specification. But the external side elevation is by a different draughtsman, and is not quite so impeccable as all the others. The outstanding discrepancies in the side view are: a wooden front buffer beam and a chimney which is tapered, though the ridiculous base depicted in the catalogue woodcut is absent.

The writer has no hesitation in saying that it is by making tracings from the Beever engravings that he is able to give to the reader the illustrations which accompany this, and will accompany the succeeding articles dealing with the *Liverpool*.

IN THE WORKSHOP

BY DUPLEX

OVERHEAD DRIVE FOR THE LATHE

THE more elaborate types of lathes used by amateurs of a past generation were often furnished with an overhead countershaft for driving the spindle of a cutter-frame that formed part of the equipment for ornamental turning. Later, the overhead drive was developed for more utilitarian purposes, and became a common adjunct of the lathe, designed for carrying out a wide range of subsidiary machining operations in the small workshop.

Nowadays, milling cutters are, perhaps, more often driven from the lathe mandrel, so that the full driving power of the lathe is available for the machining ; but it is often an advantage to be able to mill and drill the work while still mounted in the chuck or between the lathe centres. Where drills and milling cutters of small diameter can be run at high speed, the driving power available may be of secondary importance, and that provided by a round belt may be ample for many milling operations, including light gear-cutting with a suitable form of attachment.

If the design of the overhead is on simple, straightforward lines, there seems, in practice, to be no real need for the very tall kind of overhead formerly fitted to the lathe ; that illustrated in Fig. 1 stands only some 2 ft. high. This dwarf overhead, fitted to the Drummond bench lathe, is mounted on a wooden base and secured to the bench top at the back of the lathe.

The primary drive is taken by a round belt from a pulley attached to the motor-driven countershaft, which is also fixed to the bench top.

This arrangement provides for adjusting the belt tension, and to give the right direction of rotation of the drill or milling cutter, the belt is crossed.

Making the Frame

The two main uprights and the parts for the footing were made

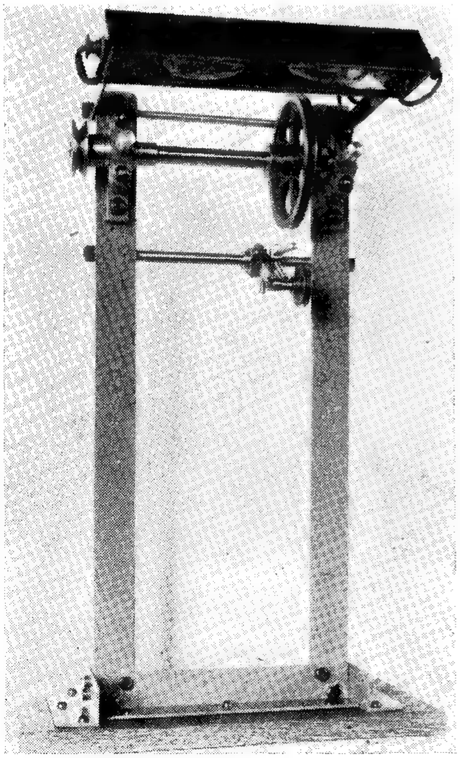


Fig. 1. The overhead fitted with a lathe light

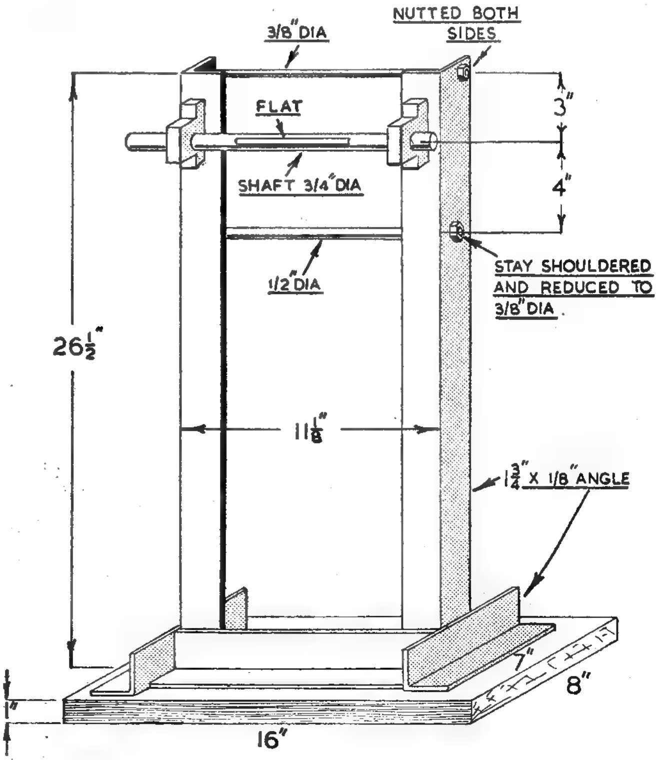


Fig. 2. The dimensions of the layout adopted

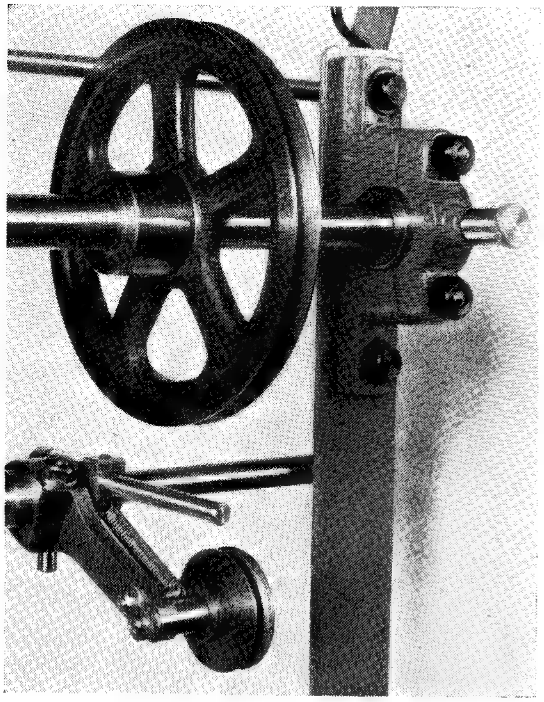


Fig. 3. The countershaft and plummer block with the belt-tensioner in position

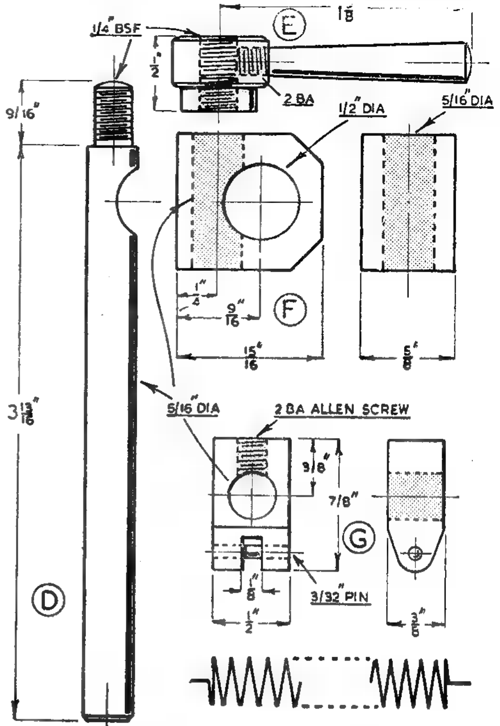


Fig. 6. The tensioning arm—D; clamp lever—E; sliding block—F; and the spring anchorage—G

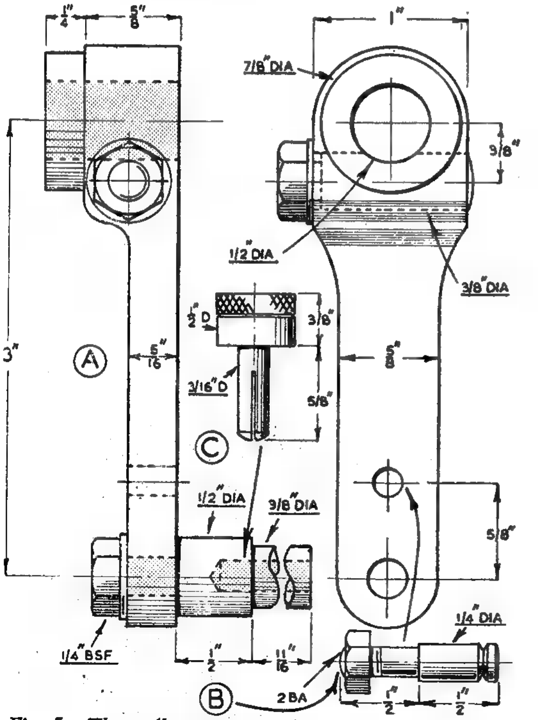


Fig. 5. The pulley carrier—A; spring anchorage—B; and the pulley retaining plunger—C

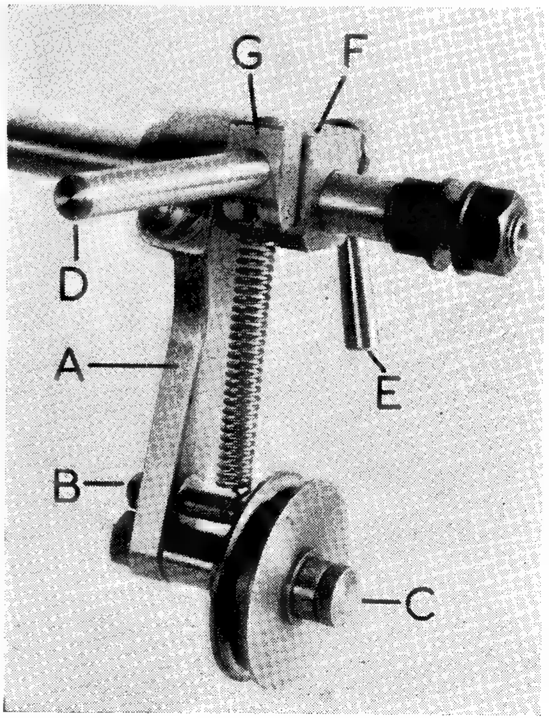


Fig. 4. The belt-tensioning device

ro n the steel angle material forming the side members of ■ household bedstead; but when selecting angle-iron from this source, it is as well to check the bed with straight-edge and try-square to make sure that the material has not been stressed beyond its elastic limit by ■ previous occupant.

The parts forming the footing should be secured to the uprights with bolts, and not by riveting, for the assembled frame has to be dismantled when fitting or removing the shaft carrying the belt-tensioning gear. The ⅜ in. diameter stretcher-rod at the upper end of the frame should, ■■ shown in Fig. 2, be fitted towards the back of the uprights so that, in conjunction with the lower stretcher, any twisting of the uprights can be corrected when nutting up. The upper stretcher is fitted with a pair of nuts at either end to provide an adjustment for length.

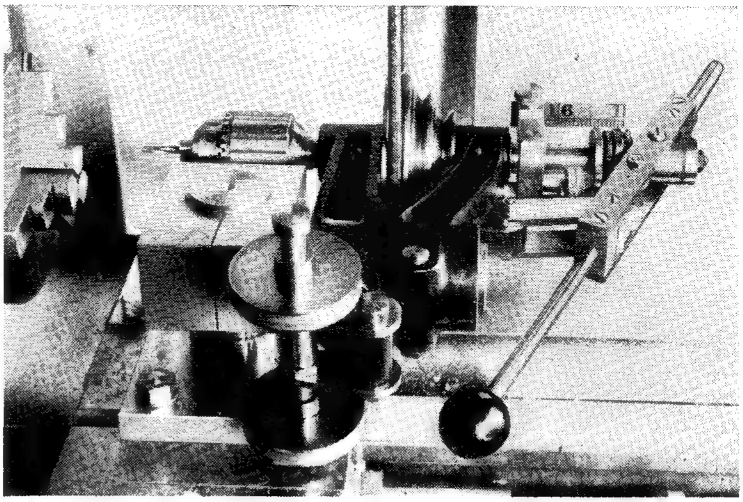


Fig. 8. The drilling-head mountea on the lathe saddle

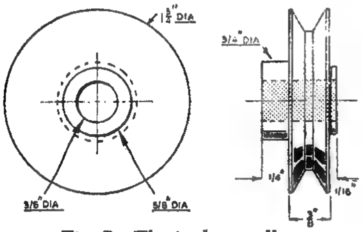


Fig. 7. The jockey pulley

The assembled frame should be carefully checked, as it is important that the two uprights should lie flat and square, in order to align the bearings correctly. The frame is next secured to ■ stout wooden baseboard with wood screws, and this, in turn, is fixed to the bench top with through bolts, to afford an easy means of detachment, should this be required.

The Countershaft

The countershaft, carrying the driven and driving pulleys, was made from a length of ground mild-steel, and the only machining required is to reduce the diameter of the shaft at one end to take the driven pulley.

The flat formed on the shaft for driving the large pulley can either be filed or machined in the shaping machine.

The shaft is located endwise by means of ■ loose shaft collar on one side of the left-hand bearing block, and the boss of the small pulley abutting against the other.

If the shaft journals are made equal to the full diameter of the rest of the shaft, the countershaft can easily be withdrawn for changing the driving pulley, or fitting the belt, without interfering with the bearings themselves.

The Countershaft Bearings

For the bearings, illustrated in Fig. 3, two plummer blocks were found in the box kept for spare fittings; these, although of an old pattern, are very well made and have accurately-fitted phosphor-bronze bearing shells. To allow for any lack of alignment, the bearings were scraped to give ■ clearance of some two-thousandths of-an-inch, and solidified oil, fed from grease cups, is used as a lubricant to ensure quiet running.

The Belt-Tensioning Device

The position of the belt-tensioner in relation to the driving pulley is shown in Fig. 3, and the device itself is illustrated in Fig. 4. The fitting is made in two parts; one to carry the jockey pulley and the other to supply the spring pressure to the jockey for tensioning the belt.

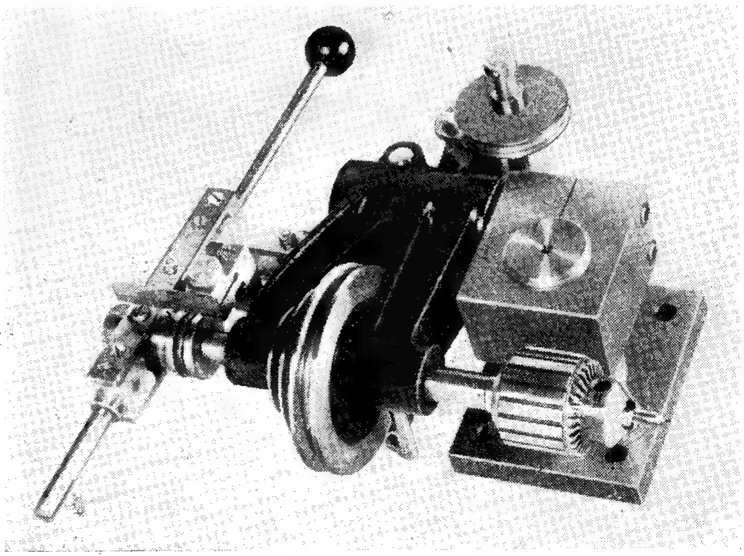


Fig. 9. The drilling-head secured to its pillar mounting

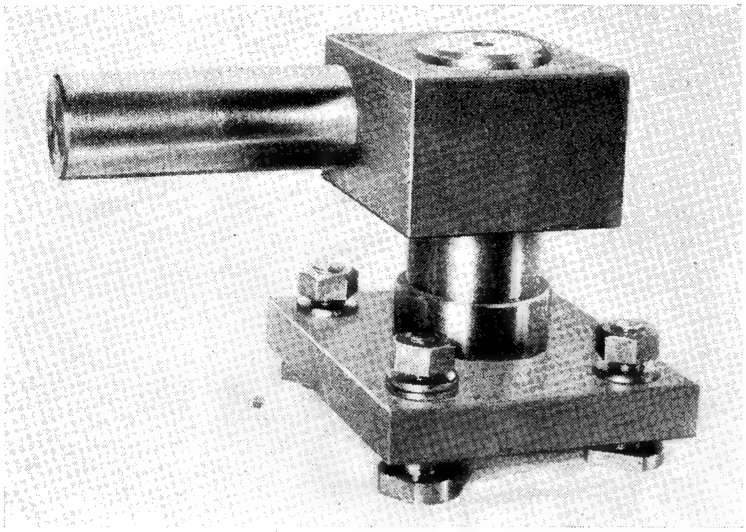


Fig. 10. The saddle fixture carrying the drilling-head

The pulley carrier (*A*) Fig. 5, was made from a cycle crank, bushed to fit the $\frac{1}{2}$ in. diameter shaft, and a short shaft is bolted to the end to form a bearing for the pulley, which is retained in place by means of the split plunger (*C*). The spring anchorage (*B*) is also secured to the arm, as shown in Fig. 4.

The half-moon cross-bolt, which replaces the cycle crank cotter, will, when needed, lock the pulley arm to its shaft.

The block (*F*) of the spring carrier slides on the shaft, and can be locked by tightening the clamp handle (*E*) after the belt tension has been adjusted. The arm (*D*) serves for setting the spring tension and also carries a sliding block (*G*) for attaching the spring. With this arrangement, not only can the spring tension be adjusted for any one position of the jockey pulley, but by sliding the block (*G*) along the arm, the spring tension controlling the pulley can be varied to remain nearly constant over a wide range of movement. To obtain quiet running and lasting wear, it is advisable to lap both the pulley bore and the spindle.

A Lathe Light

As shown in Fig. 1, the frame uprights provide convenient points of attachment for the lathe lighting equipment.

The wiring leads are carried out of sight in the angle at the back of the uprights and then pass through both the wooden base and the bench top for connecting to the supply circuit. A small push-on push-off switch is also fitted on the side of one of the angle members.

Driving a Drilling-head

So far, the overhead has been used mainly for driving the head of the "Model Engineer" drilling machine, when mounted on the lathe cross-slide, as illustrated in Fig. 8.

In this way, light milling and off-centre drilling operations are readily carried out. The advantages of using a well-designed and accurately-fitted drilling-head are that the sensitive feed can be employed, and the line of the belt does not then alter.

On the other hand, if the drill is fed by moving the lathe saddle, not only is sensitivity impaired, but the alignment of the belt is also upset. Moreover, with the drilling-head, the depth-stop and depthing-scale are available and, when the drill spindle is at the top of its travel, the thrust is still taken by the ball thrust-bearing. The drilling spindle can be adjusted radially over a wide range, both by moving the cross-slide and by swinging the drilling-head on its mounting.

The method of attaching the drilling-head is illustrated in Figs. 9 and 10, and it will be seen that the cross-slide mounting, recently described in this journal, carries a split block fitted with a stout shaft to which the drilling-head is clamped.

In this connection, it is perhaps, only right to point out to readers that the four-bolt fixing of the main pillar is in some ways superior to the method of attachment by means of a single, central bolt. It would, of course, be quite unjustifiable to assert that one way is right and the other wrong. Quick removal may

(*Continued on next page*)

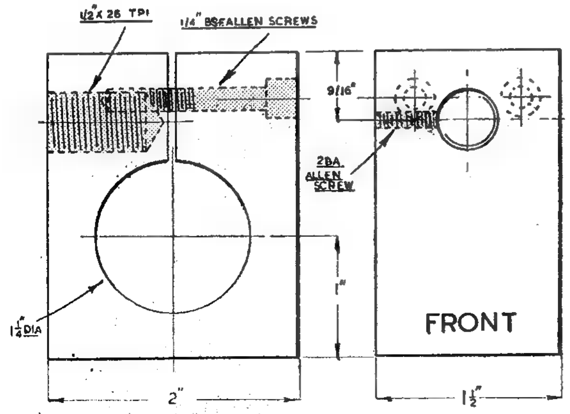


Fig. 11. Two views of the pillar clamp block

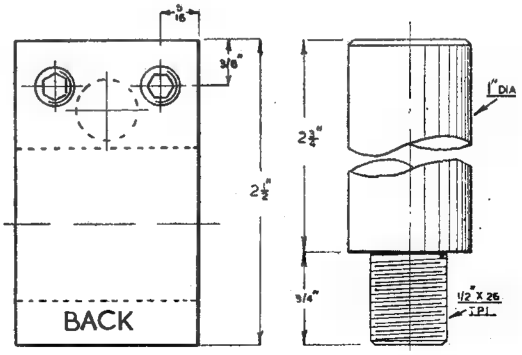


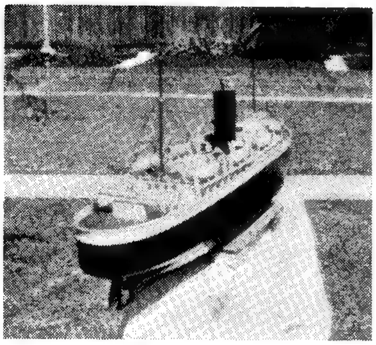
Fig. 12. The clamp block and shaft

READERS' LETTERS

■ **Letters of general interest on all subjects relating to model engineering are welcomed. A nom-de-plume may be used if desired, but the name and address of the sender must accompany the letter. The Managing Editor does not accept responsibility for the views expressed by correspondents.**

A MODEL CROSS-CHANNEL STEAMER

DEAR SIR,—I have been getting THE MODEL ENGINEER for the last five and a half years. When I was eleven I read an article on "A Model Cross-Channel Steamer, the *Brittany*," by J. E. Jane, and had always hoped to make this model boat for my first attempt.



It was not until last year that a $3\frac{1}{2}$-in. Myford lathe came my way, and I immediately got the old "M.E.s" out, November 18th, November 25th, December 2nd, 1948, and made a start.

The boat was built mostly in the school holidays. The engine, being a $\frac{7}{16}$ in. bore × $\frac{3}{4}$ in. stroke single-acting oscillating engine, was made during the Christmas holidays.

The performance was terrific, she ran for about 20 minutes, moving at a pretty good pace.

I would like to thank Mr. J. E. Jane for his very clearly dimensioned data on the cross-channel steamer, and THE MODEL ENGINEER very sincerely for the hours of pleasant entertainment that I have received from reading, and the knowledge gained.

Yours faithfully,

Sydney, Australia. JAMES M. GREIG. (Age 14 years.)

HAND ENGRAVING

DEAR SIR,—In reply to Mr. W. Bolton's letter in THE MODEL ENGINEER for March 19th, "Hand Engraving," I think I could help him.

I do not know whether he is "leg pulling" when he casually mentions T. Tompion or whether he is unaware that Thomas Tompion was the greatest clockmaker we have ever produced; he was a really wonderful craftsman. I am a practical engraver of gold and silver, which also includes the piercing and carving of the same metals. I do not think an article on the art of engraving would help a lot; the process could be described in a few words. The "secret" of the whole thing is practice, practice, practice and then some more, and, of course, a knowledge of drawing. I should say it would take him a couple of years to get complete control of the graver. The difficulty is not so much the cutting, but the ability to stop cutting when one wants to, and throw off the "swarf."

When Mr. Bolton has mastered that he will not produce slips very often. He says he obtained some diamond section gravers; the kind of engraving he refers to, however, is not produced with a graver of that section—it should be absolutely square.

The depth of cut he refers to is really an optical illusion. It is produced by what an engraver calls a flange cut, that is by inclining the graver away from you and cutting with the point plus the right-hand cutting edge; also, the graver should be whetted on both under flats, which requires considerable skill.

The whet of every engraver's graver has its own character.

Mr. Bolton says his "cut" is ragged; that is because he tries to trace the line with the graver hand. The graver should be held practically in one position and the article revolved by the left hand—really a similar process to turning.

If he is really keen to "have a go," I would willingly "whet" him up a new graver and supply a handle; it would probably cost him about 2s. 6d. Should he happen to be my way at any time, I would be pleased to show him "how it is done."

I should say that Thomas Tompion never engraved anything in his life; whatever engraving occurred on his clocks would be done by an engraver.

Yours faithfully,

Streatham. G. E. SOUTHEY.

OVERHEAD DRIVE FOR THE LATHE

(Continued from previous page)

be an advantage on the score of saving time, but the four-bolt fixing somehow looks right and it certainly distributes the clamping pressure over a wider area of the cross-slide T-slots, so that less tightening of individual bolts is required to obtain a rigid mounting of the broader base. In heavily-built commercial machines the T-slots usually have plenty of surrounding metal to withstand any heavy-handed use of the spanner, but we have seen too many broken and strained T-slots in amateurs' lathes not to be aware of the damage that can be done by indiscrimate use.

To return to the mounting of the drilling-head, the shaft is screwed firmly into the clamp block and then fully tightened by tapping the block with a mallet while the shaft itself is gripped in the vice; the Allen grub-screw is finally securely tightened.

If the block is bored, or bored and lapped, to a close fit on the main pillar, very little tightening of the two Allen cap-head screws will be needed to give a secure hold.

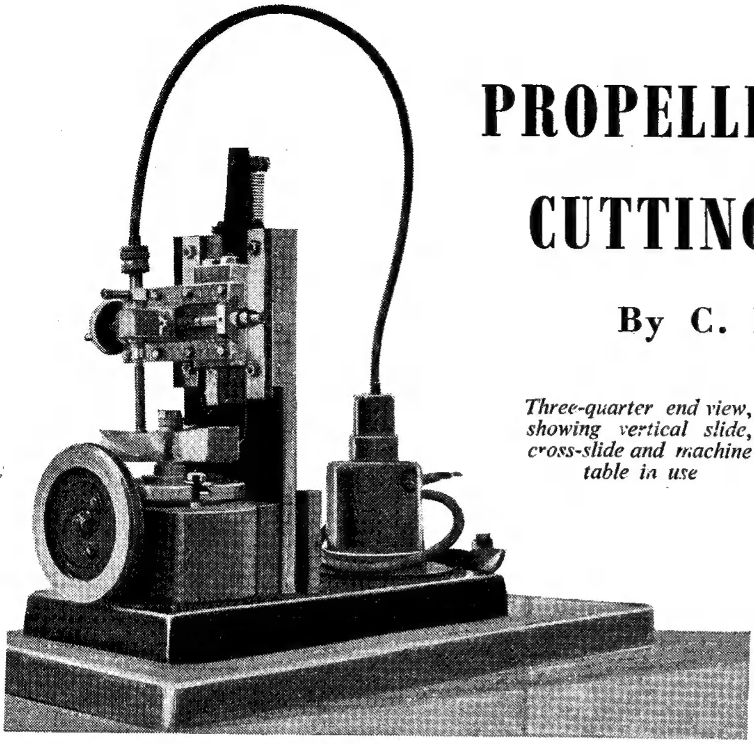
The joint in the round leather driving belt must be broken when passing the belt round the pulley of the drilling-head; that is, rather than withdraw the drill spindle.

A temporary fastener is, therefore, fitted, consisting of a strand of 18-gauge copper or iron wire; the two ends of the wire are twisted together, cut short, and then pressed down flat.

When the belt has to be removed, the fastener is cut through and withdrawn. The jockey pulley normally bears against the outside of the belt, and, to avoid the free ends of the fastener striking the pulley, the pulley groove should be machined deep enough to afford clearance for the fastener.

PROPELLER PATTERN CUTTING MACHINE

By C. H. Toogood



Three-quarter end view, showing vertical slide, cross-slide and machine table in use

THE vertical backplate was next taken in hand. This was a piece of plate cut by a welder, and required machining all over. Two holes were drilled, and tapped for set-screws, to hold it on faceplate. It was faced both sides. The ends were centred, and both ends and sides were turned between centres.

The hole to pass over the shoulder of bush of main spindle was marked off, also the slot for spindle of vertical slide. As the lathe was not big enough to swing the backplate to bore the hole, it was set up on an angle-plate, on the slide-rest. A $\frac{5}{8}$-in. hole was drilled, and with a boring bar between centres, the hole was enlarged by knocking the cutter out a little farther after each cut, and then replacing with longer cutter till required size was obtained. While the work was still mounted on the angle-plate, an end mill was placed in chuck, and the slot cut for vertical-slide spindle. The end mill was then replaced with a facing cutter, and run down the length of slide, removing about $\frac{1}{16}$ in. The idea of this was to reduce the width of surface on which the slide would work.

Two pieces of $\frac{3}{8}$-in. $\times$ $\frac{3}{8}$-in. steel were fitted to the front face of the backplate, with countersunk screws, also drilled, tapped and fitted with 2-B.A. grub-screws to adjust the slide. The two removable slide ways were made by cutting a piece off the hexagon steel. This was cut in two, and the two pieces were mounted in the four-jaw chuck, and machined on the two rough sides, three 7/32-in. holes being drilled in each for holding down set screws. This gave me two slide ways with 60 deg. angle. The slide was also a piece cut off the hexagon steel, faced on the rough side till it just slid up the slide ways when screwed down to backplate. Two $\frac{1}{4}$-in. holes were drilled from top to bottom at $\frac{3}{4}$ in. centres; steel bolts were pushed through these holes, and nuts pulled up tight.

Replacing the work in the four-jawed chuck, the hole was bored for the spigot of the horizontal slide, the bolts then being pushed out, and the heads cut off. They were then replaced, and nuts fitted, thus providing a locking device to hold the horizontal-slide in the required position.

Horizontal-slide

The horizontal-slide was next tackled. The back was a piece of flat steel. It was machined all over, bored and threaded for the spigot, which was turned to fit the hole in vertical-slide, and drilled and tapped $\frac{3}{8}$ in. $\times$ 24 t.p.i. for extension spindle. Two more strips were cut off the hexagon steel, and machined in the four-jaw chuck to act as slide ways. These were fitted to plate, with 4-B.A. hexagon-headed screws. One strip was also dowelled to locate it in position, the other strip being left movable for adjustment.

Three more pieces were cut from the hexagon steel, one piece being used for the slide, and the other two pieces used as bearings for the screwed spindle. The piece for the slide was faced on the back till it could be pushed up the slide ways. This was drilled and tapped for the screwed spindle, and a small recess turned in the front to receive the spindle bearing block. The other two pieces were faced on the back till they were a tight fit in the slide way, and drilled for the ends of screwed spindle. These bearings were held in position by $\frac{1}{8}$-in. countersunk screws.

The screwed spindle was turned between centres from $\frac{3}{8}$-in. round steel, the handwheel and set collar being turned from round mild-steel, fitted with taper pins. I tried to make a very small vertical-slide to fit to the front of the horizontal-slide, but I found it was too small to be serviceable, so I cut a block of square steel, and brazed on a flange. The block was drilled and threaded $\frac{3}{8}$ in. $\times$ 24 t.p.i. for cutter spindle bearing, after which the flange was faced, and a spigot turned to fit the recess in horizontal-slide. Two segmental slots were cut in the flange to allow it to swivel, so that the cutter remains vertical whatever the angle of the horizontal-slide. Two 4-B.A. studs and nuts hold the flange to horizontal-slide.

Cutter Spindle Bearing

This was turned from $\frac{5}{8}$-in. bronze, the lower part being turned and screwed $\frac{3}{8}$ in. $\times$ 24 t.p.i. to fit in the bearing block, drilled and reamed 7/32 in. diameter, and the top knurled to obtain a grip for adjustment. It was bored and screwed for a gland, also recessed $\frac{5}{16}$ in. $\times$ $\frac{1}{8}$ in. for the head of the cutter spindle, and the end of the flexible drive outer casing. The gland was turned and screwed to fit in the top

Concluded from page 592, May 14, 1953.

of spindle bearings, also bored a push fit on the end of the flexible drive outer casing. A brass nut, threaded $\frac{3}{8}$ in. × 24 t.p.i. and fitted with a handle, is used to lock the assembly in position after adjustment. The extension spindle from vertical-slide, to hold springs and rack, was machined from $\frac{3}{8}$-in. mild-steel, and screwed in the slide. A piece of flat steel was machined all over, bored to fit over the flange of bearing, and a tee-slot cut right across. Both these operations were carried out in the four-jaw chuck, the tee-slot being cut with the milling spindle mounted on slide-rest.

This plate was fitted to the back-plate with four $\frac{1}{4}$ in. × 26 t.p.i. set-screws, with hexagon heads, let into counterbored holes to leave the face clear, and allow the rack-guide to slide along to accommodate the size of gear being used. It is necessary to have a slot right across, as the rack is changed to opposite side, to obtain opposite-hand pattern. A flanged adaptor was turned to fit on main spindle, to take gear wheel and threaded for nuts. This was pinned to shaft with a $\frac{1}{8}$-in. taper-pin. and the flange was fitted with a $\frac{1}{8}$-in. pin to drive the gears, as is usual with lathe change gears.

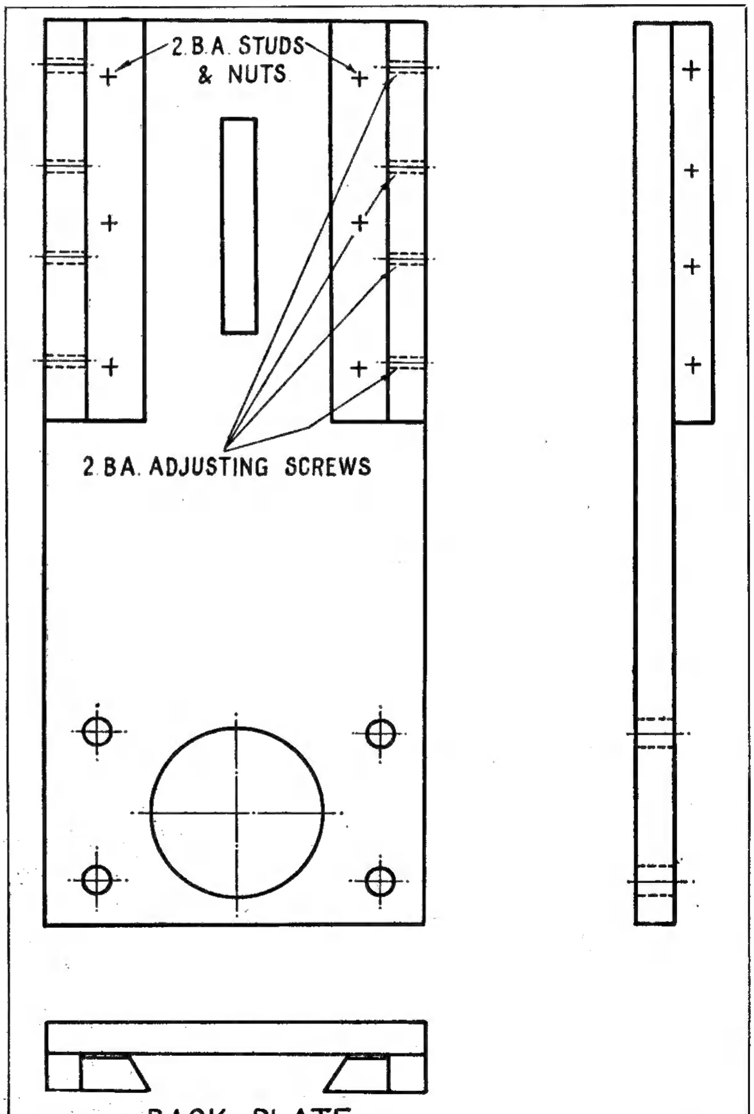
The Rack

This was tackled next. It took longer than any other part of the machine. As I had a 20 d.p. gear cutter (which I had bought some time ago to cut special change wheels) I decided to use 20 d.p. I found the circular pitch was 0.157 in., which meant that I should require a 125-hole division plate on the leadscrew, to give accurate spacing of teeth. The bull gear of my lathe has 75 teeth (20 d.p.), so I made a steel worm, 6 t.p.i. acme thread, with a spindle each end, to mesh with bull gear. A block of brass, was bored to fit on the end of the spindle, and a set collar fitted to take up end play. A steel stud was fitted to side of block, and a piece of angle-iron was fitted over the back gear bearing, with a set-screw in the hole which usually held the guard screw. The stud was pushed through a hole in angle bracket, and fitted with a spring washer and nuts, the other end of the spindle being fitted with a 50-tooth change gear. A piece of $\frac{5}{8}$ in. × $\frac{3}{16}$ in. strip steel, with one end bent at right-angles, was drilled to fit under the head of the set-screw holding down head-stock, the other end being drilled and tapped $\frac{1}{4}$ in. × 26, and fitted with a pointed set-screw to fit between teeth of gear.

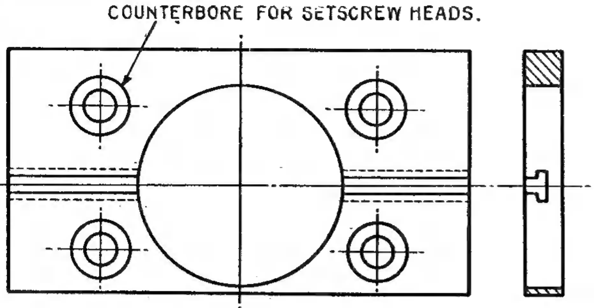
Before the attachment was set up, a circular piece of $\frac{1}{2}$-in. mild-steel plate was clamped on faceplate with two set-screws and machined all over, bored $\frac{5}{8}$ in. to fit lead-screws. The attachment was fitted up and the drilling spindle set up on slide-rest. By using every 30th space in the gear, in connection with the 75 to 1 worm reduction, I drilled my division plate. The latter was placed on the lead-screw in plate of a change wheel, and a piece of $\frac{5}{8}$ in. × $\frac{3}{16}$-in. steel was bent and drilled to fit under head of set screw holding down rear of head-stock at the other end; the strip was drilled and tapped for a pointed set-screw to fit in the holes in the division plate.

The gear cutter was mounted on the mandrel between centres, and a piece of square brass was clamped on packing pieces of suitable height on slide-rest. After each tooth was cut, the division plate on the lead-screw was revolved one turn + 32 holes. The top part of the rack was then made, and the two parts silver-soldered together.

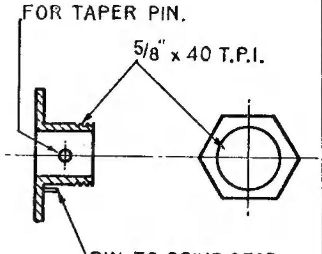
The guide for rack was milled and filed out of a piece of square brass. It is secured to plate with a 4-B.A. bolt and nut, the head of the bolt being filed to fit in the tee-



BACK PLATE

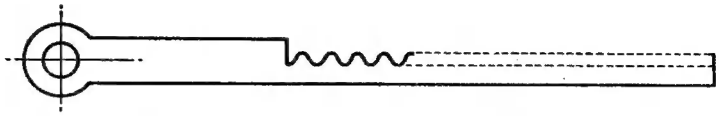


ADJUSTING PLATE FOR RACK AND PINION - STEEL.

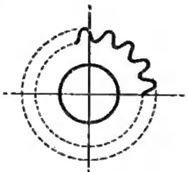


ADAPTER FOR GEAR.

BRASS GUIDE FOR RACK.

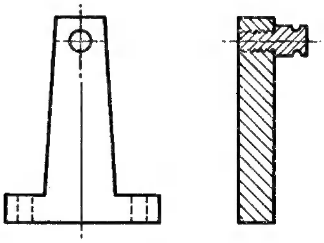


BRASS RACK 20 D.P. 5/16" THICK.



GEAR WHEEL

20 TEETH. 20 D.P.



STEEL SPRING SUPPORT.

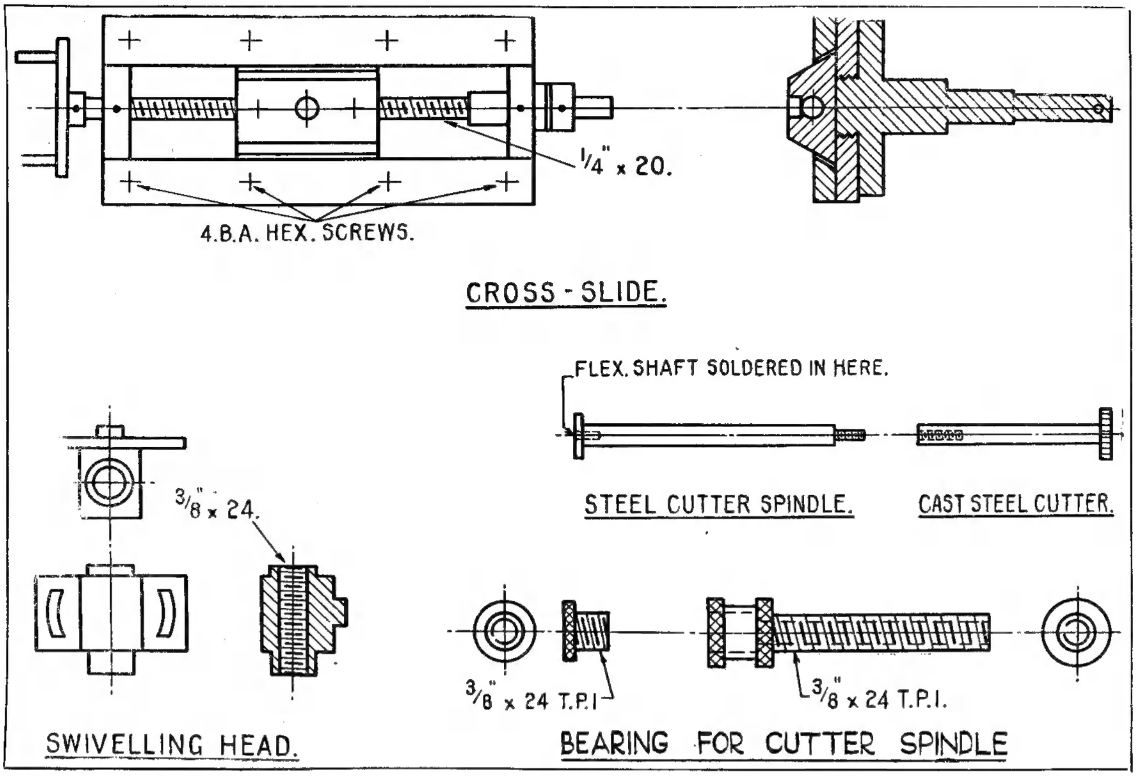
slot. A piece of flat steel was machined to shape, drilled and tapped, and fitted with a short spindle to hold the top spring. This was fitted to top of the backplate with two 2-B.A. hexagon head set-screws. A hole was drilled and tapped in the lower part of backplate, and a short spindle fitted for holding lower spring.

The cutter spindle, which was made from a piece of $\frac{5}{16}$-in. silver-steel, was turned down to 7/32 in. diameter, leaving a flange $\frac{1}{16}$ in. × $\frac{5}{16}$ in. at the top. The top was drilled $\frac{1}{8}$ in. × $\frac{5}{16}$ in. deep, and the bottom was drilled and tapped 5/32 in. × 32 t.p.i. Six different-shaped cutters were made before a satisfactory one was obtained. The final and best cutter was made from a rotary file, which was annealed, the shank turned to 7/32 in. leaving a head of the full size of file, with teeth remaining 3/32 in. thick; the end of shank was turned down and screwed 5/32 in. × 32 t.p.i. to fit in spindle, and the cutting end was re-hardened. A 5/64-in. hole was drilled in both spindle and cutter for tommy bars to screw up cutter to spindle.

Fitting and Assembling

The bevel gears were ground in with fine emery paste, the crown wheel and pinion being treated in the same way. Both vertical- and horizontal-slides, and their mating slideways, were scraped to slide freely. The machine was assembled, and a change wheel from the lathe fitted on gear adaptor. I then started on the driving gear. The electric motor was removed from its stand, and a flange was turned from an old pipe flange, to push over body of motor at one end. This was drilled for holding-down bolts. An adaptor was made from aluminium to fit over the boss of top bearing of motor, and bored at the other end to push fit on end of flexible drive outer casing. A brass adaptor was fitted to motor spindle to take flexible shaft, and equipped with two 4-B.A. grub-screws.

The cast-iron stand was chiselled and filed till it was passably flat. A slot was milled for end of rack to pass through, and a hole was drilled for the bottom bearing of motor to pass through, the motor then being bolted down to the stand. The assembled machine was attached to the stand by two $\frac{3}{8}$-in. set-screws, using the tapped holes in the base, which were drilled to hold it on faceplate. The flexible drive outer casing was pushed down the hollow mandrel, and the end of casing held in self-centring chuck; a groove $\frac{1}{16}$ in. wide, 1/32 in. deep was then cut in end of casing $\frac{1}{16}$ in. from end. A small steel washer (diameter of gland), had a slot cut out of one side, to allow it to push into the groove flexible casing, the gland being pushed over the grooved end of the outer casing, and the end of the flexible shaft soldered into the $\frac{1}{8}$ in. diameter hole in the spindle. After inserting the washer in the groove in outer casing, it was pushed down on top of bearing, and gland screwed down. The aluminium adaptor was pushed over the other end of outer casing, the end of shaft being pushed in the brass adaptor and the grub-screw tightened; finally the aluminium



adaptor was pushed down over the boss of motor bearing, and grub-screws tightened.

A disc of mahogany $3\frac{1}{2}$ in. diameter, 1 in. thick, also a disc $\frac{7}{8}$ in. diameter, $\frac{1}{2}$ in. thick, were turned and drilled $\frac{5}{16}$ in., a $\frac{5}{16}$-in. steel bolt being pushed through both discs, and then into the hole in table centre. The motor was started, and the machine performed very satisfactorily, but a more powerful motor would be an advantage.

The model was put in a local exhibition, and some person, not understanding the working principle, tried to turn the handwheel round and round, shearing off a pin. So I dismantled the machine, and bolting the base to the faceplate, I cut a tee slot on top of base 4 in. diameter. Two 4-B.A. steel bolts, $\frac{3}{4}$ in. long, with heads filed to fit the slot, were put in slot and the machine reassembled. Two pieces of $\frac{5}{16}$ in. $\times$ $\frac{1}{16}$ in. $\times$ 1 in. long flat steel, were drilled and fitted with 4-B.A. steel bolts and nuts, with heads filed to fit tee slots in table. These pieces of steel were bolted down to suitable tee slots, and bolts in circular tee slot were moved round in either direction, and set to allow the table to move only the amount required to cut the blade.

All turning, drilling, milling, gear cutting, etc., was done on a $4\frac{1}{2}$ in. screwcutting lathe. I got so "browned off" during making this machine, at the number of times that I had to change the change gears from screwcutting to fine feed, that I have now cut my leadscrew through, about 7 in. from headstock end, and made and fitted a small gearbox. This gives me a direct drive for screwcutting, a free position and a 9 to 1 reduction for fine feed.

My favourite thread is 24 t.p.i. which gives me 216 t.p.i. for fine feed, by merely moving a lever. I hope later to make drawings of this and submit them to the Editor.

FOR THE BOOKSHELF

Marine Engineering. Part II—Descriptive Catalogue. (London: H.M. Stationery Office.) 160 pages, size 6 in. by $9\frac{1}{2}$ in. Illustrations on art-paper inserts. Price 7s. 6d. net.

The catalogues of the exhibits at the Science Museum, South Kensington, London, are numerous and well-known. This one is dated 1953 and is devoted to a comprehensive description of each exhibit in the section of the museum devoted to Marine Engineering, and forms a most useful handbook on this subject. It covers: Experimental and Early Steam Propulsion; Paddle Engines after 1820; Reciprocating Steam Screw Engines; Marine Steam Turbines; Marine Internal Combustion Engines; Marine Gas Turbines; Marine Steam Boilers; Fittings and Accessories; Marine Propellers and Marine Auxiliary Machinery.

There are thirteen illustrations, most of which are from the fine models in the collection, and we think we need hardly add that the production of this catalogue is excellent. The descriptive notes are by Mr. H. P. Spratt, B.Sc., A.S.M.E., and give much interesting and useful information; because of this, the book is more of a reference book than a catalogue.

At the end, there is a complete list of inventory numbers, as well as of donors, contributors and references. The catalogue can be obtained from the Science Museum, or through any bookseller.